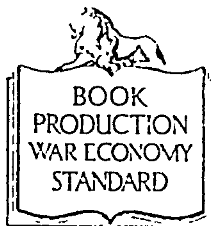
TREATMENT BY MANIPULATION

IN GENERAL AND CONSULTING PRACTICE



THIS BOOK IS PRODUCED IN COMPLETE CONFORMITY WITH THE AUTHORISED ECONOMY STANDARDS

TREATMENT
BY
MANIPULATION
IN GENERAL AND CONSULTING PRACTICE

BY

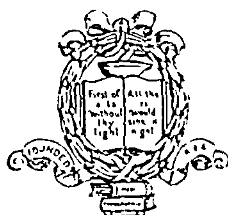
A. G. TIMBRELL FISHER

M.C., M.B., CH.B., F.R.C.S.(ENG.)

COMMANDER OF THE ORDER OF ST. JOHN OF JERUSALEM. FELLOW OF THE INTERNATIONAL COLLEGE OF SURGEONS. MEMBER OF THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS ORTHOPAEDIC SURGEON TO THE RHEUMATIC UNIT, ST. STEPHEN'S HOSPITAL. TRUSTEE AND MEMBER OF EXECUTIVE AND SCIENTIFIC ADVISORY COMMITTEES OF EMPIRE RHEUMATISM COUNCIL. LATE HUNTERIAN PROFESSOR OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND. CHAIRMAN OF NOMENCLATURE COMMITTEE, ROYAL COLLEGE OF PHYSICIANS' COMMITTEE ON RHEUMATISM, ETC

BEING THE FIFTH EDITION OF
"MANIPULATIVE SURGERY"

WITH 126 ILLUSTRATIONS



LONDON
H. K. LEWIS & Co. LTD.
1948

First edition . . . 1925
Second edition . . . 1928
Third edition . 1939
Fourth edition . . . 1944
Fifth edition . 1948

MADE IN GREAT BRITAIN

PREFACE TO THE FIFTH EDITION

In this new edition, much new material has been added, including forty-five additional illustrations. Many sections have been rewritten and expanded in an attempt to incorporate recent advances, particularly in the treatment of the crippling deformities of rheumatic disease. By such modern methods it is now frequently possible to enable rheumatic patients who have been helpless and bedridden for years to avoid the terrible necessity of being entirely dependent on others, and to stand upon their feet again. An atmosphere of despair can often thus be changed to one of hope and co-operation.

Such results, which are a great advance when one considers that, until comparatively recent times, textbooks of medicine condemned manipulation in arthritic deformities, are only made possible by team-work and the closest co-operation between physician, orthopædic surgeon, physiotherapist, nurse and all who come in contact with the patient.

Such possibilities in the treatment of conditions apt to be regarded as hopeless are still not sufficiently known and one often encounters a feeling of pessimism which is quite unjustifiable. Progress will become more rapid with the birth of a more general determination to master the difficult subject of manipulation instead of condemning it or damning it with faint praise.

Objections to manipulation are often based upon two hoary traditions. The first is the bogy of increased pain and stiffness, shock and acute reaction alleged to follow manipulation It is certainly true that some or all of these untoward results may follow lack of technical skill and an unwise choice of cases, but disaster and disappointment may be the penalty of ignorance and lack of skill in *any* sphere of medicine or surgery. However, these sequels are extremely rare in the practice of those who have the necessary skill and experience and who have acquired the knowledge of those cases suitable for manipulation, and above all, when this measure should be avoided

The second tradition consists in the view that restoration of function and of full range of joint movement can in most cases be restored by methods of physiotherapy, especially re-educational exercises and "rehabilitation." Such measures may be of the greatest value, but there is a tendency to forget their limitations.

It is frequently found that a patient improves up to a point, and that progress then ceases. It is at this stage that manipulation is often of the greatest value, and more can sometimes be achieved in five minutes of manipulation than in five months or even five years of physiotherapy and exercises

Long overdue reforms in the approach to the problem of rheumatic diseases and their adequate treatment, to which the author referred in the preface to the fourth edition of this book, may materialise in the near future. The tenth anniversary of the Empire Rheumatism Council was marked by an official Government luncheon on October 29th, 1946, at which the Minister of Health presided and affirmed the resolution of his Ministry to deal urgently with the organisation of rheumatism treatment. This resolution greatly encouraged all who have fought in the campaign for the elimination of this scourge which is responsible for so vast an amount of human suffering and misery, and, by interfering with the fitness of workers, imposes a brake on industry at a time when maximum production is indispensable for our survival as a great nation

It is the author's pleasant duty to acknowledge the help and kindness that he has received from various sources in the preparation of this book: to his publishers for their customary co-operation and courtesy; to Mr. F. Fitzgerald and Mr. L. Michaelis for their help in reading the proofs and for many valuable suggestions; to Sir Alan Daley, the Medical Officer of Health, and to his colleagues at the Rheumatic Unit at St Stephen's Hospital for their kindness and co-operation.

The author's thanks are also due to Dr. M E. Williams for notes on anæsthesia in manipulative operations and to Dr. H. K. Graham Hodgson for the loan of radiographs of tuberculous joints.

PREFACE TO THE FIRST EDITION

THIS book has been written with the object of again drawing the attention of the medical profession to the great importance and value of manipulative treatment in the treatment, **in carefully selected cases,** of certain of the sequelæ of injuries and diseases particularly affecting the joints, muscles, tendons, and fasciæ. The attitude of many of our profession towards this realm of surgery has perhaps, in the past, savoured a little of apathy and indifference, or even of incredulity. Some of the workers in this subject have held no medical qualification, but nevertheless some of their results point the moral that we as a profession owe a duty, not only to the public, but to our own self-respect and prestige, to place this therapeutic measure upon a firm foundation Let us be honest and give these men recognition for an occasional success, never forgetting, however, the disasters and disappointments that frequently happen, owing to their inevitable lack of clinical training, and in most cases profound ignorance of anatomy. One not infrequently finds misapprehension among our profession as to what manipulative treatment means and what it can achieve. Some, indeed, consider that it is a crude form of " wrenching," in which there is a haphazard application of brute force. This certainly should not apply to its practice by qualified medical men.

There is a tendency in other quarters to emphasise unduly the dangers of manipulation; but if we, as a profession, endeavoured by patient research to place the subject upon a scientific basis and to stamp out unqualified practice, the " sad examples " would thereby be reduced to a minimum. Intelligent discrimination is as necessary in this as in any other branch of surgery; and to condemn a valuable therapeutic measure " root and branch " because of an occasional unfortunate result, in an unsuitable case, is as illogical as to condemn the practice of crossing the road because sometimes a pedestrian, through carelessness, meets with disaster in so doing.

When the history of this interesting episode in medical progress comes to be written, and when events which are now taking place are reviewed with the medical historian's sense of perspective, a striking fact will stand out. Many authenticated cases existed where the bone-setter had cured, where prolonged treatment by our profession, even by its most eminent professors, had failed. Yet

the profession, with certain isolated exceptions, among whom we must honourably mention Sir James Paget, Wharton Hood, Lucas Championnière, Sir William Bennett, and Sir Robert Jones, were unwilling to make any serious effort to find out "what there was in bone-setting," or to place the subject upon a scientific basis. In medicine, as in other branches of Science, there is nothing more pernicious than a slavish adherence to dogma and tradition. Progress must be our watchword. We can learn a lesson in this respect from John Hunter. "Never ask me," he said to a pupil, "what I have said or written, but ask me what my present opinions are, and I will tell you." Sir Astley Cooper once reminded Hunter that in a previous year he had expressed a different opinion. "Very likely I did," replied Hunter. "I hope I grow wiser every year."

A fundamental reason for the prevailing unsatisfactory state of affairs lies in our ignorance of essential facts concerning the anatomy, physiology, and pathology of the articulations. How can we be sure whether to rest or move a joint when our knowledge of the physiology of the joints is almost medieval, when anatomical points are still undecided, and when our knowledge of pathology is so deficient?

It will be the author's endeavour to trace the historical steps by which the tradition of prolonged rest following injury arose. Thereafter, to describe shortly the types of cases that can be cured by manipulation, with their pathology, diagnosis, and treatment. An attempt will be made to point out the contra-indications and potential dangers, and, finally, a number of illustrative cases will be cited.

The kindness and encouragement that the author has received from innumerable sources in the preparation of this book have been an unforgettable experience, and make it difficult to tender individual acknowledgments.

Special acknowledgment, however, is due to Sir Arthur Keith and Sir Robert Jones for help and valuable suggestions, and to the Medical Research Council, under whose ægis much of the work has been done.

CONTENTS

Treatment by Manipulation

CHAPTER I

HISTORICAL INTRODUCTION

"There be of them, that have left a name behind them, that their praises might be reported."

Ecclesiasticus xliv. 8.

The word surgeon is derived from the Greek χειρουργός (χείρ hand, and ἔργον, work). The Oxford Dictionary defines a surgeon as "a medical man treating injuries, deformities and diseases by manual operation." Much of a surgeon's work is obviously manipulative in character, and the restriction of this term to the sphere which it is proposed to discuss in this book is admittedly somewhat artificial.

Any book which attempts to deal with the subject of manipulative treatment should logically include some account of the setting of fractures, the treatment of dislocations, and indeed of many other surgical procedures However, an extensive literature already exists upon such subjects, and it is proposed to discuss in this work a large and important branch of manipulative work which has not received adequate attention, and concerning which surgical literature is scanty. This aspect of manipulative treatment, to which the name "Manipulative Surgery" is sometimes given, deals with the application of forced movements of a special and often highly technical nature to joints, particularly when the movements of such joints are restricted and painful. Such interference with movement and function is usually due to the presence of adhesions or scar-tissue, but may be due to some form of internal derangement of the joint.

It is a common and widespread popular error to confuse manipulative treatment proper with the cult of osteopathy, which will be discussed in a later chapter. It is also a common error to consider passive movement to be synonymous with manipulation. Passive movement should, however, as Mennell has emphasised, involve no

375 B.C.) on dislocations has scarcely been surpassed at the present day.* Cato the elder is said to have practised bone-setting on his estate in the time of the Roman republic. From his "De Re Rustica" we learn that, in reducing a dislocation, he made use of the following incantation: "Huat hanat ista pista sista damiato damnaustra." However, is not the subject of manipulation, even in this twentieth century, still surrounded by a cloud of mystery and imagination? As an apostle of ruthlessness, a rigid disciplinarian, and the author of the famous phrase "Delenda est Carthago," the "Censor's" bone-setting operations may well have been unnerving ordeals.

The earliest hospitals were attached to the monasteries and treatment was largely carried out by members of the religious orders. It is clear that the latter performed "bone-setting" operations from the fact that Friar Moulton, of the order of St. Augustine, wrote a work entitled the "Compleat Bonesetter"—a copy of which "Revised, Englished and Enlarged" by Robert Turner, in 1656, is in the library of the Royal College of Surgeons of England.

Turner in the Preface tells us that the book is intended as a guide "for the use of those Godly Ladies and Gentlewomen, who are industrious for the improvement of their talent God has given them, in helping their poor sick neighbours."

During the passage of the centuries, surgery gradually and by slow and painful stages, became regularised and systematised, and its ranks became closer owing to the formation of colleges and corporations. During this long period, the bone-setters were among the recognised practitioners of what would now be called orthopædic surgery.

When the monasteries were dissolved by King Henry VIII the associated hospitals suffered a temporary eclipse in spite of protests by Sir Thomas More. Through the efforts of the City Corporation the five royal hospitals in London, St. Bartholomew's, St. Thomas's, Christ's Hospital, Bethlem, and Bridewell, were preserved.

A great name of this period is that of Thomas Vicary, surgeon to St. Bartholomew's Hospital. He was Master of the Barbers' Company, four times master of the Barber-Surgeons, and in the

* The Hippocratic writings consist of about seventy works. It is probable that many of them were written by various authors at different periods. Among them are, however, some that bear the stamp of genius and it is considered that they are the work of Hippocrates. They include those "On Fractures," "On the Joints," "On Setting Joints by Leverage," and the famous "Oath."

forced movement against an obstruction, should be comparatively painless, and be carried out with the muscles of the patient in a state of relaxation. If pain is felt by the patient, reflex muscular spasm occurs and further movement is forced or manipulative in character.

Patients are often sent to departments of physiotherapy with the prescription "massage, active and passive movements" but without a clear indication of the meaning of the latter term. To some doctors

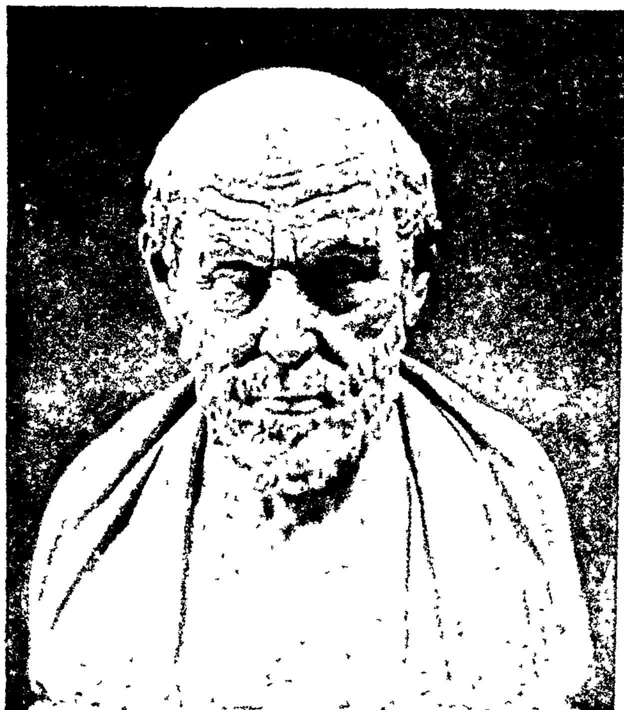


Fig. 1. Hippocrates (460 B.C.–375 B.C.).

and masseuses the term passive movement is synonymous with forced movement. To submit patients to a long course of such painful treatment when, as often, the condition can be more rapidly cured or improved by manipulation under anaesthesia is illogical. With rare exceptions, forced movement should be performed under anaesthesia and not in departments of physiotherapy.

The origin of bone-setting is lost in the mists of antiquity. Long before dissections were practised, the art of reducing dislocations had reached a high standard, and the work of Hippocrates (460 B.C.-

rest until pain and swelling had subsided, and reliance upon subsequent exercises to restore free movement. Unfortunately, a frequent sequel was as follows: An adhesion formed because the rest was too prolonged, and this became stretched by the subsequent movements, so that acute pain and swelling followed, with all the signs of inflammation. According to the Hilton school, this again

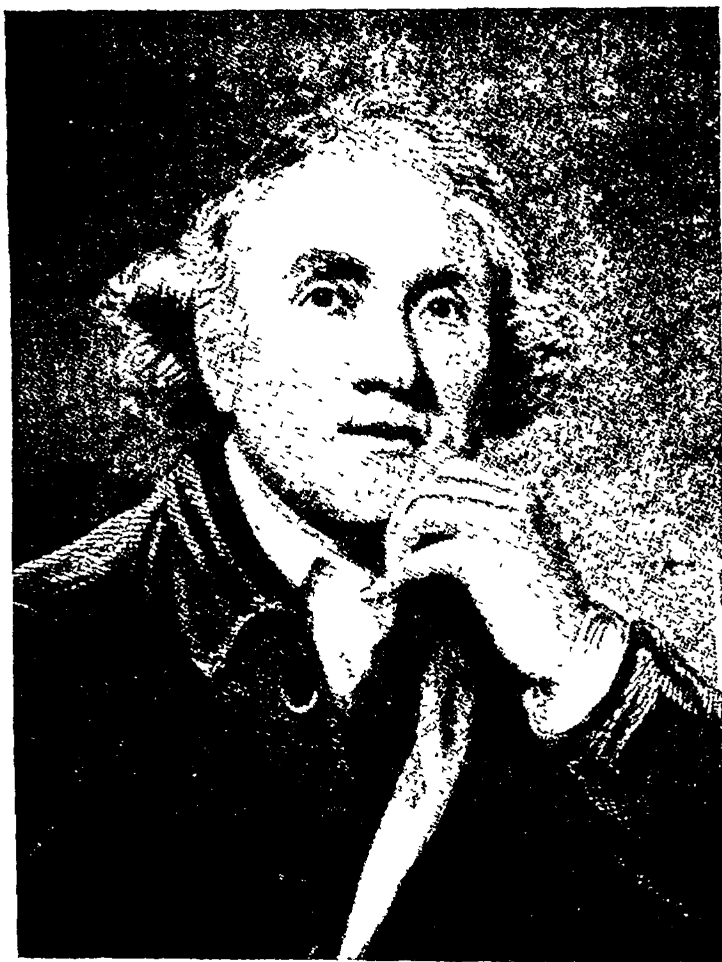


FIG 2—JOHN HUNTER (1728–1793)

demanded rest, and there was a continuation of such occurrences, associated with steadily increasing stiffness and crippling, it was not recognised that it was the presence of adhesions that caused the recurrent attacks of inflammation. Patients disappointed with their lack of progress frequently visited bone-setters and were cured by the breaking down of the adhesions.

Let us now examine the other aspect of the argument—viz., that

reign of Henry VIII united the Corporation of Surgeons with the Barber-Surgeons. He witnessed the dawn of the Renaissance in this country and was a moving spirit in the application of the heritage and stimulus of Greek thought to surgery.

In 1745, the surgeons sought sanction from Parliament to be set free from their colleagues of the Old City Guild or Company: the "Masters or Governors of the Mystery and Commonalty of the Barbers and Surgeons of London"; and were named "The Master, Governors, and Commonalty of the Art and Science of Surgeons of London." The new Company, early in the nineteenth century, became the Royal College of Surgeons of England. One of the objects underlying this divorce lay in the fact, as Sir Arthur Keith has said,* that the surgeons of London had made up their minds to have done with "mystery"; there were to be no private, secret, occult practices, but a common fund of knowledge to which all might have access.

The first Warden of the new company was William Cheselden, one of the founders of modern surgery.

John Hunter (1728-1793).

John Hunter taught the value of movements after sprains and other injuries of joints, and showed that inflammation of joints was accompanied by the outpouring of coagulable lymph and the formation of adhesions. He stated: "Nothing can promote contraction of a joint so much as motion before the disease is removed. . . . When all inflammation is gone off, and healing has begun, a little motion and frequently repeated is necessary to prevent healing taking place with the parts fixed in one position." He recognised therefore that "joint inflammation must be followed by adhesions," but held that "the parts will stretch and the motions again become free by gradual motion and by friction." This recognition of the value of movements was of great importance, but it is questionable in the light of modern knowledge whether the movements were begun sufficiently early, and, unfortunately, many of Hunter's successors misinterpreted his argument.

Let us examine this teaching, because it has had a profound influence, and can be directly traced through Hilton and Hugh Owen Thomas to modern times; taking, as an example, a sprain of such a joint as the ankle. This treatment implied keeping the joint at

* "Menders of the Maimed," by Sir Arthur Keith (Henry Frowde and Hodder and Stoughton).

of treating suppurative arthritis before the discovery of penicillin and the sulphonamides. A boy developed acute osteomyelitis of the upper ends of both tibiæ almost simultaneously. In spite of operation and free drainage, suppurative arthritis of both knee-joints followed. Both joints were opened and drained, and active



[*Guy's Hospital Reports.*

FIG 3—JOHN HILTON (1807–1878)

movements instituted from the first. With great courage, and in spite of pain, the young patient persisted in the movements, and it was noted that drainage was thereby greatly improved. He made a complete recovery, with full and painless movement of both knees, and ability to run and play games. What would have been the result in this case had the Hiltonian teaching been followed?

one may quite justifiably and deliberately allow adhesions to form, because the motions will again become free " by gradual motion and by friction." Is this theory correct? Clinical experience teaches that such a result may sometimes be anticipated after many minor forms of inflammation, but this statement is not applicable to more severe forms The time factor is also of great importance, especially in wartime. It is folly to spend months on massage, physical treatment, exercises, and rehabilitation if by manipulation the industrial worker or Service patient can be sent back to duty within a few days

It was during Hunter's lifetime that the famous Mrs Mapp used to drive up to London from Epsom in her carriage and four " to take charge of the dislocated limbs of the nobility and gentry." In a play acted at Lincoln's Inn Fields reference was made to her as the " doctress of Epsom ", she was the sister of the famous Polly Peachum and is figured in Hogarth's painting, " The Undertakers "

John Hilton (1807-1878)

John Hilton, surgeon to Guy's Hospital, in his classical book " Lectures on Rest and Pain "* laid down general principles that have proved of great value However, he carried Hunter's teaching concerning rest in injuries and diseases of joints to even greater lengths by condemning massage, movements, and exercises He was a teleologist, and regarded pain as Nature's signal demanding rest But although man must submit to Nature in the long run, he has the power, to a certain extent, of helping, guiding, and controlling Nature. For instance, unaided Nature may " cure " an acutely inflamed joint and leave it in a position of gross deformity In a sense a pestilence may be regarded as a natural process, but modern research is gradually stamping out such manifestations of unbridled Nature Similarly, we may compare the riot of vegetation in a tropical forest through which explorers have to hack their way to the cultivated beauty of an English garden in June

The fact was not sufficiently recognised that **the pain of a stretched adhesion may be an indication for forced movement or manipulation and not for rest,** and that after the adhesions have been satisfactorily ruptured in this way the pain often completely disappears. To illustrate the wrong value that may be placed upon pain as an indication of rest, a case may be described which illustrates a method

* These lectures were delivered at the Royal College of Surgeons of England in 1860, 1861, and 1862.

ment upon these figures. Sir Arthur Keith* states: "Hilton elaborated the means of securing rest into a system," whereas Thomas "made rest his creed and ritual." Hugh Owen Thomas believed that an overdose of rest was impossible, and preached his theory with great zeal, that rest must be "enforced, uninterrupted and prolonged." Sir James Paget was criticised severely. His essay, to which we shall refer later, was a "new departure in surgery," a "schism," and contrary to "the faith as handed down to us by the fathers of our art."

Hunter was born in 1728 and Thomas died in 1891; thus for more than a century and a half the doctrine of rest for various joint conditions held sway.

The attitude of H. O Thomas towards manipulation is also shown by his criticism of the famous lecture by Sir James Paget, published in the *British Medical Journal* of January 5, 1867, and to which reference is made below. "For many years after the commencement of my experience in surgery," he states, "I had the opportunity of observing the practice of those who had acquired a good reputation for skill as successful manipulators"; and he goes on to say "I cannot find suitable cases upon which I would perform the deception known as passive motion." It is difficult to understand his indictment of this measure unless we remember that Thomas, as his nephew Sir Robert Jones used to emphasise, based his observations largely upon the havoc the bone-setters of his day sometimes brought about by their manipulation of tuberculous joints.

We may conclude this short review of the views of H O. Thomas upon manipulative treatment by quoting the following extract from a letter, which shows in a striking manner the other side of the question "In my own case, after submitting to Mr. Hutton's† manipulation, I was instantly relieved from that pain, tension, and coldness in the joint that I had suffered for six years, and was able to walk . . Professional men accounted for the manifest change in my condition on one hypothesis and another, whilst all affected to smile at my ignorance and delusion. . . I had been lame and in pain, and could now walk and was at ease . . ., and had the whole College of Surgeons clearly demonstrated to their entire satisfaction that I could not possibly have been benefited by Mr. Hutton's treatment, my opinion would not have been in the smallest degree shaken by it."

* "Menders of the Maimed" (p 6), by Sir Arthur Keith (Henry Frowde and Hodder and Stoughton).

† A well-known bone-setter, see p. 13.

H. O. Thomas (1834-1891).

The orthopædic principles of Hugh Owen Thomas of Liverpool must now be briefly touched upon in so far as they apply to our argument. His pioneer contributions to surgery were of great importance and he had mechanical genius. He is a shining example of a busy general practitioner who by his clinical work won fame and renown. His nephew, Sir Robert Jones, in the first triennial Thomas Memorial Lecture on April 25, 1922, said: "I lived with him in close and affectionate communion for over twenty years of the most strenuous period of his professional life. . . . When I look back upon those early years when he preached as one in the wilderness and when his work was either ignored or discountenanced, it is little more than a romance that thirty years after his death, when all but great reputations have perished, we are assembled to inaugurate triennial lectures in his memory." But there can be no doubt that he was somewhat prejudiced against manipulation. Both the father and grandfather of Thomas were bone-setters, and he worked with his father both before and after he had taken a medical qualification. A quarrel arose and there was a parting of the ways. Although Thomas had clearly learned lessons of the greatest value from his father, after the quarrel,* his opposition to unqualified practice and to manipulation became intensified and bitter. Whatever we may think of his attitude towards this subject, we cannot close our eyes to the fact that, largely owing to his splint and its early application, the mortality of fractures of the thigh was reduced during the world war of 1914-1918 from 80 to 20 per cent. and the results during the second world war have shown still further improve-

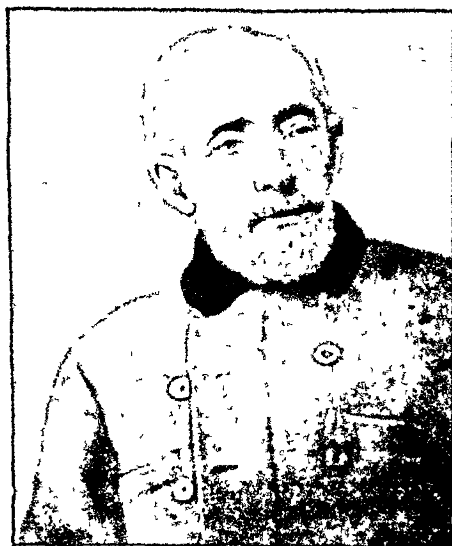


FIG 4—H O THOMAS (1834-1891)

* McMurray states, "The disagreement with his father seemed to eat deeply into his mind and to colour his whole outlook on the activities of unqualified bone-setters" T P McMurray, "The Life of Hugh Owen Thomas," *Liverpool Medico-Chirurgical Journal*, 1935, xliii, 3.

painful, and therefore contravenes the teaching that pain is Nature's indication for rest. We now know that the pain of early movement is largely due to reflex muscular spasm, and can be largely prevented by appropriate measures and, in particular, by massage of the lightest, gentlest, and most superficial nature, the so-called "effleurage."

Next we come to the consideration of a strange fact. The medical profession, although their methods of treatment tended to produce such numbers of stiff joints, almost entirely neglected that vast field—the treatment of stiff joints by manipulation. What was the underlying reason for this neglect? The answer is twofold: (1) The fear of wrenching a tuberculous joint. (2) A disinclination to admit that any good could lie in a method practised by unqualified persons. From time to time, disasters occurred owing to the wrenching by a bone-setter of a joint which had become stiffened through tuberculous disease. On the other hand, a number of stiff, swollen joints which were crippled by traumatic adhesions or some form of mechanical derangement were condemned to long periods of immobilisation because they were mistaken for tuberculous disease or "white swelling." For instance, in 1738, Thomas Simson, Professor of Medicine in the University of St. Andrews, wrote to Dr. Alexander Monro describing "an instance of what is called by our English writers 'the white swelling of the joints,' which arose from a most singular cause" This proved to be a loose body formed of bone and cartilage. The resulting traumatic synovitis was wrongly diagnosed as tuberculous disease. It is probable also that many other cases of internal derangement due to mechanical causes were mistaken for tuberculous disease. It seems strange to us, as we look into the past, that because manipulation in a particular group was contra-indicated, this method of treatment should have been so generally condemned. But a brighter day was gradually dawning Although there have been long periods during which our profession has been unduly influenced by dogma and tradition, yet original minds have eventually arisen who have been prepared to examine and, if necessary, champion any form of treatment which, although unorthodox, was in their conviction, of definite value.

Sir James Paget (1814-1899).

This famous surgeon of St. Bartholomew's Hospital was pre-eminently endowed with these qualities. In the *British Medical Journal*, January 5, 1867, appeared his famous lecture entitled "Cases that Bone-Setters Cure" He began his lecture with the

If we attempt to summarise the teaching of Hunter, Hilton, and Thomas, we see that all attached extreme importance to rest while the slightest form of inflammation existed in a joint. Pain on movement due to mere muscular stiffness or the presence of adhesions was also often considered to indicate the presence of inflammation. They realised that during rest plastic lymph became organised into adhesions, but maintained that full movements could be restored by subsequent use of the affected limb. It is a touching faith in this erroneous doctrine, in spite of abundant evidence which disproves it, which still impels many surgeons to immobilise the fractured femur for a long period without knee-bending. It also accounts for the spectacle of disabled Service patients grimacing with pain as they work away, often for many months, with weights and pulleys in a vain attempt to mobilise their stiffened joints, the mobility of which could often be restored in five minutes by appropriate manipulation.

But in addition to the great number of stiff joints caused by this attitude, it must be remembered that multitudes of such stiff joints were and are still caused by the "classical" treatment of fractures and dislocations. At the present day it is still not sufficiently recognised that these methods are responsible for much permanent deformity and interference with function The fractured limb may be immobilised in splints or plaster for a long period, or swathed in elegant bandages, and no serious attempt made to prevent secondary muscular contracture or stiffness of adjacent joints. Many of such stiffened joints might have been prevented by closer co-operation between surgeons responsible for the earlier treatment of fracture cases and departments of physiotherapy. The surgeon often concentrates all his energies upon obtaining firm union of the fracture in good alignment. The patient is then sent to the department of physiotherapy to remedy the stiffness of the adjacent joints, and the surgeon is not always aware of the difficult problem which he has set his colleagues. Minor cases of joint stiffness respond as a rule in a satisfactory manner to the ordinary methods of physical treatment, but in others, months of painstaking after-treatment are required, and in others there is a legacy of permanent stiffness "Look after the bones and the joints and soft parts will look after themselves" appears to be the motto of many surgeons who are responsible for the treatment of fractures In the treatment of reduced dislocation, every effort is sometimes concentrated upon healing the rent in the capsule, and few care if, to achieve this, permanent muscle shortening occurs or the joint becomes crippled by adhesions Besides, movement is often

who practised in the West End of London, to learn something of his methods. This invitation was extended because Hutton had been a patient of Wharton Hood's father, Dr. Peter Hood,* during a serious illness; and Dr. Hood, knowing of the bone-setter's gratuitous services to the poor, refused to receive any fee for his services. The bone-setter's views upon the nature of the lesions present were somewhat primitive; in almost every case a "bone was out" and had to be replaced. Yet his results were often brilliant, even if disaster sometimes followed his manipulation of a tuberculous joint. Patients who had been treated by orthodox methods for years would sometimes throw aside their crutches and walk unaided from his doorstep. Wharton Hood, after learning the bone-setter's methods, used to assist in treating some of his poorer patients.

Considering that an account of his experience would be of value, he published in the *Lancet*, after Hutton's death in 1871, a series of articles explaining the bone-setter's methods, and pointed out everything that he had been shown. As he himself stated, "the whole mystery of 'bone-setting,' precisely what it could do and where it was useless or injurious, was laid open to the medical profession in the plainest language." The papers were subsequently published in the form of a treatise on bone-setting.† This work, a pioneer and valuable contribution to surgery, was largely overlooked, partly because bone-setting was regarded as something not quite respectable, and partly because the teachers of his day did not accept it and excluded it from the curricula of the schools. One writer has stated that "if Dr. Wharton Hood had held an appointment in a London hospital and had done his work before students, it would long ago have been universally known and imitated by surgeons. But the actual teachers were not sufficiently prompt to acknowledge and welcome the work of a man who was not a member of their own body, and the students had no opportunity of seeing its value."

It was well pointed out in an article in the *British Medical Journal* of September 3, 1910. "Not to go so far back as Harvey, who was denounced by the leaders of the profession in his day as a circulator or quack, we need only recall how the open-air treatment of consumption was ridiculed when the idea was first put forward by Bodington. . . . Famous physicians refused to listen to Pasteur because he was not a medical man, Lister was scoffed at; the laryngoscope was sneered at as a 'physiological toy', the early

* A busy general practitioner in Knightsbridge, London, to whom his son was at that time acting as assistant

† "On Bone-setting," by Wharton P. Hood, M R C S., M D , 1871.

shrewd observation, "Few of you are likely to practise without having a bone-setter for a rival; and if he can cure a case which you have failed to cure, his fortune may be made and yours marred." He described the types of cases which could be benefited by manipulation, and ended his essay with the advice: "Learn, then, to imitate what is good and avoid what is bad in the practice of bone-setters."



FIG. 5—SIR JAMES PAGET (1814–1899).

He had no hesitation in condemning the prevalent practice of prolonged rest, the origin of which we have endeavoured to trace. "Too long rest," said he, "is, I believe, by far the most frequent cause of delayed recovery after injuries of joints, and not only to injured joints, but to those that are kept at rest because parts near them have been injured." Although Sir James Paget's position as a surgeon with an international reputation was already established, and he commanded universal respect and esteem, the medical profession paid little heed to his wise advice.* Prejudice was too deeply entrenched.

Wharton Hood (1834-1916).

A few years later, a pioneer work by Dr Wharton Hood was published which drew warm praise from Paget himself. Hood, whose aim was the Hunterian one of arriving at the truth, whatever its source, accepted the invitation of the bone-setter Richard Hutton,

* Sir James Paget was one of the greatest orators that our profession has ever known. Mr Gladstone used to divide people into those that had heard Paget deliver an oration and those who had not. After Paget's Hunterian oration in 1877, Mr Gladstone proposed the toast of the orator in his masterly way. When Paget's turn came to reply he said, "There is only one way it is possible to surpass Mr Gladstone as an orator. You all know that although speech may be silvern, silence is golden. You shall have all the gold."

CHAPTER II

PATHOLOGY

We may, for convenience, classify the cases that may be cured or benefited by manipulation into four main groups; although certain cases are combinations of one or more groups:

(*a*) Articular or peri-articular adhesions.
(*b*) Subluxations and dislocations of joints, tendons, or intra-articular discs.
(*c*) Adhesions in connection with muscles, tendons, or fasciæ.
(*d*) Certain functional or hysterical conditions of joints and of the spine.

(*a*) Articular or Peri-Articular Adhesions.

An adhesion is a contracted band or area of scar-tissue due to the organisation of inflammatory products.

Pathology.—Although combinations of the various types frequently occur, adhesions in connection with joints may be divided into:

(*a*) Intra-articular—*i.e.*, inside the true capsule of the joint and involving the synovial membrane lining its deep surface or some intra-articular structure, such as the infrapatellar pad of fat in the knee-joint or the tendon of the biceps in the shoulder-joint.

(*b*) Articular—*i.e.*, scar-tissue in the joint capsule itself or in its accessory ligaments, as in many sprains involving joints. In many cases, both the capsule and the synovial membrane lining its deep surface may be involved.

(*c*) Peri-articular—*i.e.*, scar-tissue in ligaments, tendons and their sheaths, in bursæ and even in muscles which are in the vicinity of, but external to, the joint Good examples of this are the limitation of extension of the knee-joint due to shortening by scar-tissue of the lower portions of the tendons of the biceps, semitendinosus, semimembranosus, and other flexor tendons, and actual shortening of these muscles, and periarthritis of the shoulder-joint (frozen shoulder)

Articular adhesions are a common sequel of sprains of joints and of various types of synovitis and arthritis. They are very often encountered in rheumatic disease. Very frequently, articular, intra- and peri-articular adhesions coexist, and not rarely, secondary

ovariotomists in this country were threatened by colleagues with the coroner's court; electricity was looked upon with suspicion."

At the present day, we find that, in spite of the efforts of Sir James Paget, Wharton Hood, Sir William Bennett, Sir Robert Jones,* and others, manipulative treatment does not receive the attention that it merits. Although in other realms of medicine great strides have been made, manipulative treatment still lags behind The subject, with a few isolated exceptions, is not sufficiently emphasised in the curricula of our medical schools. There is inadequate research into the fundamental underlying principles, and Hutton's successors are still occasionally effecting cures in cases which have baffled some of the most eminent members of our profession. Even if it could be proved that disaster or disappointment frequently followed manipulation—and there is no evidence that this is the case—cures are so many and so well authenticated that the subject demands the fullest investigation.

But destructive criticism alone is of little real value. The subject must be taught by lectures upon the underlying pathology and by actual practical demonstration in our medical schools and hospitals. The cry is often raised that we must not add fresh courses to the already overburdened medical curriculum, but this is one which must definitely be included, and taught by those with the necessary experience, and in which the medical student must produce evidence of having received instruction before qualification. As the field for the clinical training of the medical student increases, by so much must be diminished the period at present devoted in his preliminary years to the laborious assimilation of facts of little value to him in his future career in medicine. Interests and enthusiasms must be aroused. Research must be conducted into underlying physiological and pathological principles; careful records must be kept, the subject must be set occasionally for prize essays; questions must be asked in examination papers or at the examination board, and clinical lectures and demonstrations must be given at every hospital, for every out-patient department contains cases which urgently need manipulation †

* Lord Dawson of Penn, in Liverpool Cathedral on February 5, 1933, echoed the thoughts of all who were privileged to know this great surgeon, in these words "Scientific thinker, inventive craftsman, teacher, leader of men, he gave himself and through his disciples great service to mankind"

† The final paragraphs of this chapter, which appeared in previous editions, are deliberately retained It is gratifying to be able to record, however, that during recent years a marked increase of interest has occurred Manipulative treatment is now recognised as an important branch of orthopædic work Numerous discussions have been held at medical meetings, further books and papers have been published, and the subject now arouses growing interest

ligament or cartilaginous disc. Synovial adhesions are particularly liable to occur at those anatomical sites in every joint where layers or folds of synovial membrane lie normally in contact, especially in the position which the joint tends to assume when inflamed. The existence of these opposed layers of synovial membrane can be well demonstrated by sections through joints, a method of anatomical



FIG 6.—ADHESIONS IN REGION OF LOWER PART OF INFRAPATELLAR PAD OF FAT OF KNEE-JOINT

study which is valuable, and one which might with advantage be more often used. For instance, there is no better way of mastering the complicated anatomy of such a joint as the knee than sections in various planes. By this means, synovial recesses may be demonstrated which sometimes escape notice in textbooks of anatomy.

Some of the commoner sites where layers of synovial membrane

muscular shortening may also be present, associated with scar-tissue in the substance of or around the muscles, with loss of their elasticity and contractility. This may form the principal obstruction to movement, as after many fractures and dislocations. In cases of long standing, all the structures on the side of contraction may undergo adaptive shortening.

There are two principal conditions of joints in which adhesions are particularly liable to develop, although it is important to bear in mind that often no clear-cut line of demarcation can be drawn between them:

(*a*) Synovitis, both acute and chronic.
(*b*) Arthritis, acute, subacute, or chronic.

A traumatic synovitis due to sprain or other injury frequently passes by imperceptible degrees, and particularly if treatment is inadequate, into a condition of traumatic arthritis.

In synovitis, the inflammation involves the synovial membrane, and often, as we have seen, the capsule or peri-articular structures, whereas in true arthritis the articular surfaces also participate. In early cases, the articular cartilage only is involved, but in later, the subarticular bone may also show changes. It is therefore clear that, good as the results of manipulation in this last group may be, they are not so complete or permanent as is usual in the first group. The prognosis also depends to a certain extent upon the cause of the synovitis or arthritis. Traumatic cases have, as a rule, a better prognosis than those due to infection or toxæmia. In the latter, the results, however, are often good, particularly in the chronic rheumatic group, if the cause has ceased to act, if measures be simultaneously taken to eradicate this factor, and with the exercise of careful discrimination.

Leriche maintains that an injury to a joint is at first accompanied by vaso-constriction of the articular vessels due to sympathetic stimulation. This is, however, soon followed by vaso-dilatation, which causes œdema and effusion, excessive vascularity of the synovial membrane, decalcification of the bones, calcification in the soft tissues, and contracture of the ligaments.

Intra-articular adhesions are of various types The adhesions may be in the form of thickened and contracted bands of the lining layer of the synovial membrane itself that have resulted from a previous attack or attacks of synovitis On the other hand, bands of every shape, size, and thickness may stretch across the joint (Fig. 6), connecting two more or less distant portions of synovial membrane, or may connect the latter to the articular cartilage, to an intra-articular

limitation of joint movement that exists is due almost entirely to conditions existing outside or even at a distance from the joint. It should be particularly noted that most of them are avoidable by early preventive measures. Some of the principal of these conditions may be enumerated as follows:

(*a*) Stiffness of a joint following fracture in its vicinity.

(*b*) Contractures occurring in cases of paralysis.

(*c*) Contractures following burns.

(*d*) Contractures following prolonged suppuration.

(*e*) Contractures due to prolonged functional immobility.

(*f*) Contractures due to a slow process of sclerosing fibrositis such as Dupuytren's contracture.

(*g*) Ischæmic contracture

(*h*) Contractures following loss of muscular substance or division of tendons.

In some of these conditions, manipulation is of value, provided that it be followed by appropriate after-treatment. It is in this group that a combination of manipulation with tenotomy, tendon lengthening, or other operation is frequently indicated. It is often necessary to perform a series of manipulations, after each of which the improved position is maintained by means of splintage, preferably in the form of a plaster case.

The type of case which has been described above must be carefully distinguished from that in which the limitation of movement is due to a bony obstruction, as after many fractures into or in the neighbourhood of joints, and in certain cases of chronic arthritis. In many of these, the limitation is due to both scar-tissue and bony obstruction, and manipulation combined with open operation may be of benefit.

Mode of Formation of Adhesions.—It is difficult or impossible to achieve our ideal of preventing the formation of adhesions unless we have some knowledge of what an adhesion is and how it is formed. Most of us are aware of the pathological changes that take place in inflammation, and if we apply this knowledge to inflammation as it affects joint structures, we shall see that the phenomena differ in no important particulars from those seen elsewhere. There are the same vascular and cellular phenomena in the synovial membrane and connective tissues of the joint. In the central part of the articular cartilage, however, which is devoid of bloodvessels, the cellular phenomena greatly exceed in importance the vascular, in fact, the latter may in slight cases be entirely absent.

During an acute attack of synovitis, there is an outpouring of plastic lymph from the bloodvessels of the synovial membrane, and

are in contact in the position of greatest ease which the joint tends to assume, when inflamed, will be dealt with under individual joints.

In more serious forms, in which the articular surfaces have themselves been involved in the inflammatory process, leading to a loss of a portion of their structure, adhesions of various degrees of density may stretch between these surfaces. Fibrous ankylosis may ensue, and not infrequently cartilaginous or even bony transformation may occur in the fibrous tissue, leading to osseous ankylosis. The term "true ankylosis" is better limited to those cases where adhesion exists between the articular surfaces; "false ankylosis" arises from causes outside the joint, and involves peri-articular tendons, muscles, fasciæ, skin, etc. When intra-articular adhesions have given rise to some quite definite limitation of movement of the joint, it is common to find, in later stages, secondary shortening of the joint capsule, of adjacent tendons, and even, in advanced stages, of vessels, nerves, and other important structures.

Synovitis leads to the formation of intra-articular adhesions. The limitation of movement produced leads to secondary contraction of the articular capsule, which may be considered Nature's way of preventing any movement which causes painful stretching of these adhesions. Secondary contracture of peri-articular muscles and tendons occurs in severe cases from fibrosis; the latter often proving perhaps the most potent factor in preventing return of full movement, and one of the most difficult factors to treat. For instance, in the knee, where flexion is limited, the secondary shortening of the quadriceps tendon may require lengthening by operation; and when extension is limited, the hamstring tendons may require similar lengthening. In certain cases, the intra- and extra-articular fibrosis may occur concurrently. It is important to bear in mind this frequent sequence of events, as it has an important bearing upon treatment As we shall see later, the ideal to be constantly borne in mind is to **prevent the formation of adhesions if in any way possible,** for prevention is obviously better than cure (see Chapter III). If intra-articular adhesions have formed, treatment should be undertaken as early as possible, before permanent contracture of capsule and peri-articular structures has occurred.

Limitation of Movement of Joints due to Extra-Articular Causes.—In the foregoing remarks, we have dealt principally with stiffness of joints due to intra-articular adhesions, and have mentioned that, in certain cases, secondary contraction of peri-articular structures may occur.

There is, however, a large and important group in which the

thick and fleshy (Fig. 7), or form narrow bands or delicate filaments (Figs. 6 and 8). There is reason to believe that, as in the peritoneal cavity, an adhesion originally short and broad may by gradual stretching become long and narrow. Furthermore, portions of synovial membrane may adhere not only to other synovial processes, but may contract adhesions to intra-articular ligaments or menisci, or to the articular cartilage itself. There is thus no mystery

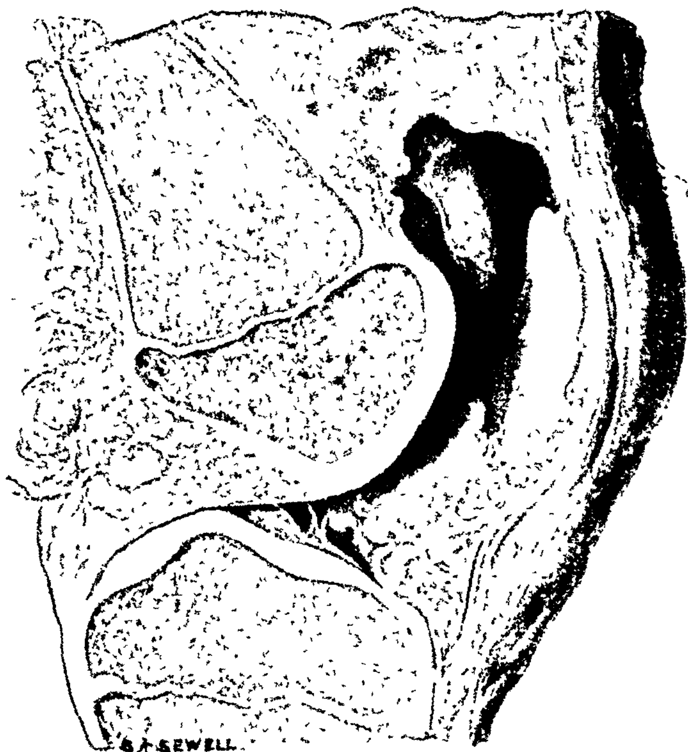


FIG 8 — KNEE-JOINT SAGITTAL SECTION. DELICATE ADHESIONS IN SUPRAPATELLAR POUCH AND IN VICINITY OF INFRAPATELLAR PAD OF FAT FOLLOWING SYNOVITIS.

(Museum of Royal College of Surgeons of England, Hunterian specimen)

about the underlying pathology of adhesion formation; it is in accordance with the well-known phenomena of inflammation.

Direct and Indirect Methods of Formation of Synovial Adhesions.*—In the **direct method**, opposed synovial layers denuded of their surface endothelium are at first glued together by plastic exudate. This exudate is derived from plasma which has become coagulated

* See also "The Natural Formation of Acquired Adhesions," by Sir G. Lenthal Cheatle, *Lancet*, October 30, 1926, p 898.

those folds and portions of synovial membrane which lie in contact when the joint is at rest tend to become glued together by plastic exudate. If the joint is kept at rest too long, it is easy to see that the plastic exudate will become organised and converted into



FIG 7 —KNEE-JOINT, IN WHICH THICK, FLESHY ADHESIONS ARE PRESENT, COMBINED WITH CONSIDERABLE DESTRUCTION OF ARTICULAR CARTILAGE.

(Museum of Royal College of Surgeons of England)

connective tissue; thus an adhesion is formed These adhesive bands acquire in time an endothelial covering, become smooth and glistening, and all except the very minute contain bloodvessels. These adhesions may be single or multiple, broad and band-like,

achieve, but in the less acute, gentle active movements, begun almost immediately, may prevent the adherence of synovial layers by this plastic exudate. Multitudes of stiff joints might have been prevented by attention to this rule.

The important question must now be considered: Can prolonged immobility of a healthy joint lead to ankylosis? Hilton, in his classical work, stated that he believed this theory to be untenable. He agreed that changes probably took place in the cartilage, ligaments, and muscles, but believed that such deteriorations were only temporary, "for reparation is perfected in all these structures by careful and steadily increasing use or employment, and after a time they show no defect." H. O. Thomas held similar views. He considered that the stiffness of the knee, which so often follows a fracture of the femur, was not an example of stiffness following immobility of a normal joint, for he argued that the knee in such cases had been injured at the time of the fracture. Both these authorities dismiss the problem of the stiffness of the joints adjacent to a long immobilised fracture in a somewhat cursory manner. Although "reparation" may be "perfected" in some cases "by careful and steadily increasing use or employment," it is a matter of everyday experience that in a disturbingly large number of cases this is not so. Long immobilisation of the fractured femur without knee-bending is apt to cause stiffness of the knee-joint, which never completely recovers. In such cases, a form of false ankylosis results from the causes mentioned below, which often proves a difficult problem in treatment, particularly in the case of patients who are no longer young.

The Influence of Immobility, Disuse, and of Œdema in the Formation of Peri-Articular Adhesions.*—The factors that cause peri-articular adhesions to form around joints, which have not themselves been subjected to injury, but which it may be necessary to immobilise for a period, are of fundamental importance in the surgery of fractures.

The influence of a *comparatively short* period of immobility alone upon a normal joint is usually slight and recoverable by simple measures, particularly if the patient is young. For instance, if a plaster splint is applied to the shoulder-joint for a fracture in its vicinity, and if the elbow and wrist are included in the plaster, it is usually found that the stiffness of the latter joints, which is probably due to venous congestion, disappears after a few weeks with natural use of the joints by the patient. This satisfactory outcome is

* See also "Adhesions of Joints and Injury," by R. Watson-Jones, *Brit. Med. Jour.*, May 9, 1936, vol. 1, p. 259.

through the agency of fibrin ferment developed principally from breaking-down leucocytes. Organisation of the plastic lymph joining together the opposed layers of synovial membrane and consequent adhesion formation takes place through its invasion by cells which develop into fibrous tissue.

The **indirect method** accounts for the formation of the long strands of adhesions so often encountered in joint cavities. In such, the plastic exudate not only forms a layer upon the surface of the synovial membrane, but may be deposited in the joint cavity. Strands of fibrin are formed from the collections in the joint cavity, and establish contact there with similar areas on the surface of the synovial membrane.

The fibrinous strands thus formed are invaded by fibroblasts and bloodvessels from these attached surfaces, and later become covered with a layer of endothelial cells. Sometimes the plastic exudate in the joint cavity becomes converted into fibrinous melon-seed bodies

This brings us to an important point—viz., in some severe cases of synovitis, and in most cases of arthritis, the articular cartilage may be involved. There is a proliferation of the cartilage cells at the surface, some of which may revert to connective-tissue cells and mingle with plastic exudate formed by the synovial membrane, thus adhesions which may vary from delicate fibres to those of a dense fibrous nature form between the articular surfaces In many cases of arthritis a layer of connective tissue or "pannus" may spread over the articular cartilage from the periphery, where it is derived from the synovial membrane. When two adjacent layers of "pannus" become opposed, ankylosis may result.

In some forms of chronic arthritis the pathology differs, particularly in the osteo-arthritic type. There may be no plastic exudate, but chronic sclerosing inflammatory changes occur in the synovial membrane and peri-articular structures, a slow and insidious shortening and contraction of the connective tissues is brought about, associated with gradually increasing deformity In some cases of severe contusion or fracture into a joint, a hæmorrhagic effusion occurs (hæmarthros), in such there is a particular risk of resulting adhesions

The bearing that these facts concerning the birth of adhesions have upon treatment will be discussed more fully in another chapter It will be sufficient to emphasise here that, although we cannot always prevent the occurrence of plastic exudate, yet in the treatment of any inflammatory condition of a joint, wherever possible, **movement must be instituted before organisation of the plastic exudate occurs.** In some acute forms this ideal is impossible to

be broken in one place but may join again. If, however, it is broken at two or more places by a concentrated attack, this is unlikely. The co-operation of a psychologist should therefore be sought in difficult patients.

Such cases of what we may call the "classical" types of joint neurosis are infrequent when compared with the vast numbers of joint troubles in which there is a definite organic basis but with a superadded psychological factor. This combination is frequently encountered in injuries and diseases of the joints, and particularly in rheumatic joint conditions.* It is apt to supervene when treatment has been uninspired, prolonged and disappointing, and a sense of frustration and lack of confidence results. These are the patients who, thoroughly disgruntled with doctors, rush off to osteopaths or bone-setters.

Good results can usually be achieved in the latter group by manipulation if the surgeon or practitioner and all concerned in the after-treatment have the gift of inspiring the patient with confidence and co-operation. Team-work is the secret of success and a long course of after-treatment should be avoided, if possible, as this tends to refix the neurotic factor temporarily abolished by the manipulation.

It is at present only dimly realised what an extremely important part neurosis plays in many joint cases. They may be divided into four main subdivisions:

1. Cases that are entirely functional.

2. Cases that were functional originally, but upon which from disuse an organic element has become superimposed in the form of adhesions, fixed muscular contracture, or even arthritic changes.

3 Cases in which a functional element has been superimposed upon a definite organic disease of a joint, such as arthritis, or upon some long-standing lesion, such as intra- or peri-articular adhesions.

4. Cases of malingering upon which a genuine functional element has supervened.

Of these four subdivisions, the third is probably the most frequently encountered, and purely functional cases are less common than is sometimes supposed. The actual pathology of subdivisions 2 and 3 does not materially differ from that we have already described, but clinically there are, of course, very important differences. Only a very careful investigation of the history of a case can tell us whether we are dealing with subdivision 2 or 3, although this point is of somewhat theoretical interest. In these cases, with the

* "The Psychological Aspects of Chronic Rheumatic Joint Disease," by Philip Ellman and Sidney M Mitchell, Reports on Chronic Rheumatic Disease, No 2, 1936, pp 109-119

expedited if the patient has moved the fingers freely during the period of immobilisation.

Even when fracture exists in the immediate vicinity of the joint which is immobilised, the resulting stiffness need not constitute a serious problem in the absence of disuse and œdema. Good results may be anticipated in fractures of the carpal scaphoid, which have been immobilised for six weeks or longer, in an accurately fitting plaster splint which permits full movement of the fingers. The pressure of the splint prevents œdema in the joints in the vicinity of the fracture. This œdema is a sero-fibrinous exudate and has been well described as the "glue of which adhesions are made" (Watson-Jones). If, during the wearing of the plaster, the fingers are actively used, functional disuse, which is another potent cause of peri-articular adhesion formation, is also eliminated, and the residual stiffness after removal of the plaster can usually be rectified by simple measures. It must be borne in mind that movements of the muscles and tendons in relation to an *immobilised joint* are not so valuable in preventing articular adhesions as actual free movement of the joint. Long continued immobilisation of the joints adjacent to a fracture may lead to obstinate stiffness even if active muscular contractions without actual joint movement are encouraged.

(*b*) **Functional or Hysterical Conditions of Joints.**

These constitute a large and important group. The classical type of hysterical joint, such as Charcot described, is now comparatively rarely seen. It is maintained in some bizarre position by marked muscular spasm; for instance, the knee may be kept fully or rigidly flexed or extended. In other cases the symptoms, such as pain, are out of all proportion to the physical signs, which may be absent. The patient is often a young woman of nervous temperament and with a recent history of some injury or of some emotional disturbance

In cases of marked neurosis it must be remembered that the symptoms are often a manifestation of some deep-seated psychological condition which requires sympathetic treatment. It is often possible to cure the spinal or joint condition but, so long as the patient's goal remains the same, when one symptom is given up another is often found Such patients become "virtuosos of neurosis, continually extending their repertory" (Adler) Good results from manipulation, however, are often seen if the patient can be removed from harmful influences and simultaneously given a fresh, hopeful and co-operative outlook on life, otherwise, disappointment is inevitable. By manipulation the vicious circle may

coming a flexion deformity. Pathological subluxation of the tibial head with displacement backwards and outwards combined with external rotation is common in advanced cases of arthritis of the knee, comparison being necessary with the opposite side. According



FIG 9 —OSTEO-ARTHRITIC CHANGES IN WRIST-JOINT WITH SUBLUXATION
Note also the marked thickening of the carpo-metacarpal joint of the thumb and a Heberden node in index finger

to many osteopaths, a "subluxation" is defined as an immobilisation of a joint in a position of normal motion, usually at the extremity of a given movement.

(*d*) Adhesions in Connection with Muscles, Tendons, or Fasciæ.

Adhesions may occur in other situations in the locomotor system in addition to the joints They occur frequently in or around muscles, or in fasciæ and connective-tissue layers as the result of injury, such as contusion or sprain, and are often encountered in rheumatism Such injuries are commonly seen in athletic individuals. Rider's sprain of the adductor longus, rupture of the plantaris in tennis players, partial ruptures of the quadriceps extensor cruris in footballers, are a few examples of a large group. In many of these the scar-tissue formed in the process of healing leads to a certain amount of limitation of movement which may be rectified by manipulation. In the cases following injury, a hæmorrhagic exudate first occurs, which is gradually replaced by fibrous tissue, whereas in those due to rheumatism, collections of inflammatory cells gradually undergo the same conversion.

The pathology of these conditions will be briefly indicated under individual headings.

possible exception of the fourth category, satisfactory results may be obtained by manipulation, provided that the changes are not too advanced and that the mental condition has not become too fixed.

(*c*) Subluxations and Dislocations of Joints or Tendons.

The field of manipulative treatment in the reduction of gross dislocations is large; as, however, the methods are described in surgical textbooks, the discussion of this subject will be omitted. It should be borne in mind that it is unwise, and often dangerous, owing to the risk of fracture, to attempt the reduction of a dislocation of several weeks' standing by manipulation except when combined with open operation. In these cases, secondary muscle shortening has occurred, in addition to scarring and contracture at the site of the rent in the capsule. Furthermore, in some cases, as in dislocation of the shoulder, important nerves or bloodvessels may have acquired adhesion to the displaced head, and any attempt at reduction is then attended with grave risk of injury to these structures.

Fracture-dislocations of the semilunar cartilages of the knee-joint are an important field for manipulative treatment and will be described in Chapter VI.

A form of internal derangement may occur in the temporo-mandibular joint, often associated with mechanical locking.*

In medical terminology, a subluxation is a partial displacement, not amounting to a complete dislocation, the articular surfaces have a relation to each other which they do not assume during the normal joint movements—*i.e.*, the movement is beyond anatomical limits. Such displacements usually occur in arthrodial or gliding joints: such as the sacro-iliac, carpal, tarsal, and the joints between spinal articular processes, but are quite frequently seen in other joints (Fig. 9). They may be due to trauma or disease, pathological subluxations being frequently encountered in chronic rheumatic forms of arthritis. Subluxations can usually be best demonstrated by stereoscopic radiography A form of traumatic subluxation which is all too frequently seen in the knee is the displacement backwards of the tibial head after excessive or wrongly applied force in over-

* Howard Marsh in his "Diseases of the Joints" tells of a lawyer whose jaw at some critical moment in a speech to the jury would suddenly become locked so as to fix his mouth in a half-open and asymmetrical position Casting an appealing glance at the judge and jury and looking unutterable things at his learned friend opposite, he would rush into an adjoining room, and having by a trick that he had acquired, got his jaw in again, would return and continue his address.

Human joints contain a small quantity of pale, straw-coloured viscous fluid, the quantity in the human knee-joint averaging 0·2-0·3 c.c. It is alkaline in reaction (*p*H 7·5-7·7). The calcium content is high compared with serum, as is also the concentration of chloride and bicarbonate, but the concentration of sodium, potassium and magnesium is lower than in serum. The protein content of synovial fluid is slightly lower than that of the blood. There appear to be two principal channels of absorption from the joint—viz.,



FIG 10 —DEMONSTRATION OF LYMPHATICS OF SYNOVIAL MEMBRANE BY INJECTION OF COLLOIDAL SILVER INTO KNEE-JOINT OF LIVING RABBIT.

absorption by the capillaries and the lymphatics of the synovial membrane Absorption of isotonic solutions and of diffusible dyes introduced experimentally takes place fairly rapidly through the synovial capillaries. Colloidal substances of greater molecular composition are more slowly absorbed by the synovial lymphatics. Particulate matter is probably transferred to the subsynovial stratum by the synovial cells and phagocytes; after hæmorrhage, hæmosiderin can often be found in this situation

Substances such as urea, amino-acids and uric acid find ready

CHAPTER III

PREVENTION OF ADHESIONS

RECENT years have witnessed a change of outlook towards the problems of rest and movement in injuries and diseases of the locomotor system.

This change of outlook may be summarised by stating that in former years the average medical man turned instinctively to rest and splintage. Now, however, he is becoming more and more alive to the importance of modern methods of physical treatment, and particularly of early movement, by which many of the unfortunate sequelæ of injuries and diseases of the locomotor system may be prevented.

The pathological aspects of adhesion formation have been described in a previous chapter.

Let us, before discussing the problem of prevention of adhesions, examine certain points concerning the physiology of joints, and particularly of synovial membranes, a knowledge of which is helpful in arriving at guiding principles concerning the alternatives of rest or movement for injuries and diseases of joints.

Physiology of Synovial Membranes and Synovial Fluid.

The author's experimental work[1] upon the absorption from synovial cavities of solutions of varying molecular composition showed that movements of the joint expedited such absorption. It is reasonable to suppose, therefore, and this is confirmed by clinical experience, that *carefully controlled and gently performed* active movements play an important part in the absorption of the inflammatory effusions associated with traumatic or infective synovitis. Such movements, therefore, may prevent articular adhesions, not only by minimising the risk of adhesion between opposed layers of synovial membrane, but by bringing about absorption of the "glue of which adhesions are made." On the other hand, if the movements are excessive and uncontrolled it is obvious that synovitis will be aggravated, with further production of inflammatory exudate, and increased stiffness of the joint will result.

[1] For a more complete account see "Some Researches into the Physiological Principles underlying the Treatment of Injuries and Diseases of the Articulations," *Lancet*, 1923, ii, pp 541-548 "Chronic (Non-Tuberculous) Arthritis," H K Lewis and Co , Ltd

starch reaction, showing that the potassium iodide solution had been absorbed by the synovial membrane and finally excreted by the kidney. The experiment also demonstrates the important part played by movement in assisting the absorption of the fluid. It is obvious that this process of absorption might have occurred by means of either the capillaries or lymphatics, or possibly both might have played a part. A further series of experiments was performed in an endeavour to ascertain the respective part played by these different elements.

Absorption of Diffusible Dyes.

Experiment 9 (*Old Series*) —The above experiment was repeated, using a solution of Berlin blue; 2 c.c. were injected into the joint, gentle movements were instituted, and after a short interval a further 1 c.c. was injected At the completion of the experiment the animal was killed and the joint opened and examined. A small quantity of Berlin blue solution remained in the joint. There was a generalised diffuse staining of the membrane present, more marked in the suprapatellar pouch On further examination it was seen that the dye lay in the subendothelial layer of the membrane, but no injected lymphatics could be detected either proximal or distal to the joint. Microscopic examination of a portion of the membrane from the suprapatellar pouch showed an absence of lymphatic injection save at one small area. This experiment would appear to point to the fact that diffusible dyes are somewhat rapidly absorbed by the capillaries into the venous circulation, and only to a slight extent by the lymphatics.

Absorption of Colloidal Dyes of Greater Molecular Composition.

(*a*) **Berlin Blue and Mucilage of Tragacanth**—*Experiment* 1 (*New Series*) —A saturated aqueous solution of Berlin blue mixed with an equal quantity of mucilage of tragacanth was prepared to approximate as closely as possible to the composition of normal synovial fluid; 1·5 c.c were injected into the knee-joint of a rabbit, the animal was allowed to move freely about, and was killed in five hours It was found that absorption by the lymphatics had certainly taken place, for microscopic examination of the membrane revealed these clearly. No obvious staining of the lymphatic glands was detected. The striking thing, however, was that the whole of the circulation of the animal was stained a vivid blue, showing that absorption by the capillaries had readily occurred.

(*b*) **Colloidal Silver**—*Experiment* 4 (*New Series*) —A solution of 2 per cent colloidal silver in normal saline was injected into both knee-joints of a rabbit. The animal was allowed to move about freely until killed five hours later. The synovial lymphatics were thus demonstrated in a very striking manner, the colour varying from dark brown to black. Furthermore, the popliteal gland, the lymphatics along the course of

access to joints. Glucose is found in a lower concentration than in the blood, probably because it is utilised by the joint structures.

The problem of joint mucin is interesting and important, and further work is necessary upon this problem.

Mucin-secreting cells in the synovial membrane were described by the author in 1923 and Kling in 1938. At one time mucin was considered to be derived from breaking down of the superficial cells of the articular cartilage, but it is now known that mucin derived from this source contains sulphur, whereas the mucin of synovial fluid is sulphur-free. Meyer in 1939 isolated its viscous polysaccharide element as hyaluronic acid. An enzyme, hyaluronidase, which is found in the testicular extract and other tissues and also in some bacteria, has the property of breaking down hyaluronic acid, destroying its viscosity, and finally hydrolising it. Although more work on the subject is needed, it appears that mucin plays an important part not only in lubricating the joint surfaces but, in combination with calcium, in maintaining the alkalinity of the synovial fluid and protecting the joint against the action of toxins.

Small though the normal quantity of synovial fluid is, its formation, circulation and the removal of waste products from the joint doubtless depends upon regular exercise. Possibly some abnormality of the joint mucin leading to diminution of its viscosity may prevent normal lubrication of the articular cartilage and may play some part in the onset of the degenerative type of arthritis. Also some diminution in its antitoxic properties may possibly be incriminated in some forms of rheumatic arthritis. This would appear to be a promising line of research. In synovitis and arthritis, carefully regulated movements of the affected joint play an important part in the absorption of articular effusions.

Absorption of Isotonic Solutions.

Experiment 6 (*Old Series*) —The needle of a 5 c c syringe was inserted obliquely into the inner side of the suprapatellar pouch of the knee-joint of an anæsthetised rabbit, 1 5 c c of a sterile solution of isotonic potassium iodide was then slowly injected until the joint became tense Absorption appeared sluggish at first, but after alternate passive flexion and extension of the joint, which was repeated several times, there was appreciable slackening of the joint tension. Sufficient fluid was then injected again to distend the joint cavity The experiment was continued for five hours, and at intervals of fifteen minutes 1 c c of the solution was introduced The total amount of isotonic potassium iodide absorbed during this period was about 20 c c Urine collected from the bladder at the termination of the experiment gave the typical

clearly, therefore, of great importance. The normal strength and stability of joints depend to a great extent upon the muscles in relation to them; and in certain situations, as in the hip and elbow, to the shape of the articulating surfaces. The action of the joint ligaments is in the main supplementary, and under normal circumstances they are protected from excessive strain by muscular action. The shoulder-joint affords a good example, for if the muscles and tendons in relation to the joint be all divided in the post-mortem room, the voluminous capsule of the joint permits a wide excursion of the head of the humerus.

A sprain is often, therefore, but by no means invariably, associated with a muscular or tendinous strain or rupture. In the knee, for example, severe force applied to the outer side of the limb in the region of the joint may cause such marked abduction that the tendons on the inner side are strained or partially torn. The force, continuing to act, may bring about sprain or rupture of the internal lateral ligament mainly involving the long or superficial portion, and possibly associated with a lesion of the internal semilunar cartilage or some other complication. For instance, a scale of bone may be separated from the region of the upper attachment of the internal lateral ligament. Every severe sprain of a joint should be X-rayed as a matter of routine. Sometimes after a sprain of the upper attachment of the internal lateral ligament, calcification occurs in the injured area—the so-called Pellegrini-Stieda "disease."

On the other hand, a sudden rotation of the knee when the protecting muscles are taken off their guard, may cause a sprain, mainly involving the deep fibres of the internal lateral ligament, and frequently associated with a lesion of the internal semilunar cartilage.

The guiding principles in the treatment of such sprains should be the avoidance of undue strain upon the damaged ligament, combined with the institution of immediate, but carefully controlled, active movement. The avoidance of undue strain upon the damaged ligament permits healing to take place; and the institution of early active movements ensures that the healing takes place without contraction of the ligament by scar-tissue, which may cause a subsequent impediment to the free movement of the joint. Such movements also prevent or minimise disuse atrophy of the muscles that act upon the joint, and also assist the absorption of intra-articular effusion. Any form of forced or passive movement is contra-indicated in the early stages, for this breaks down the reparative tissues and can only cause increased painful reaction and indefinite prolongation of disability. Active movements which are too strenuously performed may also be harmful, so that the intelli-

the femoral vessels, the iliac glands, lymphatic vessels along the course of the abdominal aorta, and even glands near the entrance of the thoracic duct, were demonstrated. There was a certain amount of absorption into the general circulation, due either to absorption of colloidal silver by the synovial capillaries directly into the blood stream or access to the circulation may have been obtained through the thoracic duct. It is probable that both occur, but that in the case of such colloidal substances the principal route of absorption is through the lymphatics.

It was possible to show that movement, as in the case of the isotonic solutions and diffusible dyes, plays a very important part in the absorption of colloidal silver.

In another series of experiments, a similar quantity of colloidal silver was injected into the knee-joints of two rabbits. In one rabbit the joint was immobilised, whilst the other animal was allowed to move freely about. At the end of a fixed period of time both animals were killed. It was found that in the immobilised joint the lymphatics in the synovial membrane could usually be demonstrated, but no proximal lymphatics or glands were stained. In the case of the animal in which movement had been permitted, the proximal lymphatic vessels and glands were demonstrated by the colloidal silver in a very striking manner. As an instance the following experiment may be quoted.

Experiment 5 (New Series)—Rabbit B.—1·25 c c. of colloidal silver (2 per cent. in normal saline) injected obliquely into suprapatellar pouch of right knee at 10.30 a.m. No obvious extravasation occurred and the puncture was sealed with collodion gauze. The animal was permitted to move about freely on recovering from the anæsthetic and was killed at 12.8 p.m.

Rabbit A.—Similar injection made into the right knee at 10 50 a m, but animal was kept under the anæsthetic and no movement occurred. It was killed at 12.28 p.m.

Post-mortem Examination.—Diffuse staining of synovial membrane present in the injected knee of both rabbits. In rabbit A no lymphatic glands or lymphatics proximal to the joint were stained, whereas in rabbit B, in which movement had been permitted, the popliteal gland was stained a dark brown, the iliac glands on the right side were stained a light brown, and there were a few faintly stained lymphatics along the abdominal aorta.

Applications of Physiological Principles to Treatment.

(*a*) **Early Movement in Sprains and Other Injuries of Joints.**—These injuries are frequently associated with synovial effusion, it has already been observed that inadequate treatment of such injuries and of the accompanying plastic exudate is a potent cause of adhesion formation and favours the development of traumatic arthritis. The prevention of adhesions following such injuries is

ments, a helpful device being the introduction of a $\frac{1}{8}$ to $\frac{1}{4}$ inch wedge on the inner side of the heel.

With the disappearance of the acute symptoms, more active treatment is indicated, with the object of restoring the full range of joint movement and the normal bulk and tone of the thigh muscles as soon as possible. Of these muscles, the quadriceps extensor is the most important, and unless strenuous efforts be made by the patient to restore the tone of this muscle, a condition of "quadriceps insufficiency" may develop with complaints of weakness and a sensation of "giving-way" of the knee, often associated with general instability of the joint. Space will not permit a detailed description of the measures to be adopted in the re-education of the quadriceps, but exercises against resistance in the later stages, such as sculling or bicycling, both of which can, if more convenient, be performed at home or in a gymnasium on suitable machines, are of great value. Faradism to the quadriceps may supplement these measures.

Similar principles are applicable to sprains of other joints.

In sprains of the ankle and wrist of slight and moderate degree a useful alternative method is to strap the damaged ligament with elastoplast, which should not completely surround the joint. Use of the affected region in moderation then assists repair, and the movement of the peri-articular tendons prevents adhesion formation.

(*b*) **Acute Inflammations of Joints.**—The rôle of movement in acute inflammations of joints is naturally a limited one. When the articular cartilages have been destroyed, the pain and spasm produced by even the slightest movement are so intense that it is ruled out of practical politics. What is the cause of the muscular spasm so characteristic of acute and of many chronic diseases of joints? It must be remembered that the synovial membranes of joints are richly supplied with nerves. There is a plexus of both medullated and non-medullated nerves in the synovial membrane, and end-organs of various types have been described both in it and in the villi. Irritation of the nerves and of the nerve-endings causes reflex spasm of the muscles acting upon the joint. John Hilton's law states: "The same trunks of nerves, whose branches supply the groups of muscles moving a joint, also furnish a distribution of nerves to the skin over the insertions of the same muscles and—what at this moment especially merits our attention —the interior of the joint receives its nerves from the same source" ("Lectures on Rest and Pain," Lecture VII). In cases where suppuration occurs and is largely limited to the synovial membrane, good results may follow if free drainage is provided. The pioneer work of Willems is of historical interest in this connection. The

gent co-operation of the patient is necessary. When the patient is nervous, some assistance may be given by the physiotherapist in the performance of the active movements (*i.e.*, **assisted movements,** which differ essentially from passive and forced movements).

It should be our aim gradually but steadily to increase the range of movement and to obtain full movement without undue delay.

Treatment of sprain of the internal lateral ligament of the knee-joint may be given as an example.

In marked cases, associated with considerable reaction and synovial effusion, rest from weight-bearing upon a couch is ordered at first. The joint is bandaged firmly over a thick layer of wool and the position of greatest ease is usually with the knee slightly flexed and supported by a pillow. Strapping should not be used as it interferes with the physical treatment mentioned below, and actually makes adhesion formation more probable

From the first, the compression bandage is removed once or twice daily for massage of the limb, followed by gentle active movements and faradism to the quadriceps. The massage may be accompanied or preceded by radiant heat, which is of value in relieving pain and muscular spasm.

The patient is also encouraged to flex and extend the knee at frequent intervals without removal of the compression bandage, for such movements, in combination with the elastic compression, aid materially in the absorption of joint effusion

If a plaster-of-paris splint is used, this should be bivalved as soon as the plaster has set. The two sections of the splint can then be removed for physical treatment and active movements, and rebandaged in position at the end of each session.

In cases of actual rupture of the internal lateral ligament a plaster-of-paris splint is desirable This is also bivalved and the anterior segment only is removed for electrical treatment and re-education of the quadriceps without interfering with the healing of the torn ligament.

Leriche advocates the injection of novocain into the damaged ligaments directly a sprain has been diagnosed. Pain is thus abolished, and it is claimed that early movements can be carried out by the patient with confidence and adhesion formation prevented.

When the more acute symptoms have subsided and joint effusion has lessened, walking in strict moderation may be permitted. The movements entailed, together with the pressure exerted by the compression bandage, assist in the absorption of the joint effusion and prevent muscular wasting. Strain upon the recently damaged ligament should be eliminated by the avoidance of rotatory move-

underlying this treatment depended not only upon the prevention of ankylosis, but upon the improved drainage that occurred. During flexion and extension, certain synovial recesses are compressed and others cease to exist, and the pus, taking the line of least resistance, escapes via the openings for drainage. If the latter did not exist there would undoubtedly be risk of diffusion of the septic material along intermuscular planes.

The discovery of the sulphonamides and of penicillin has revolutionised the treatment of open wounds of joints and has not only markedly reduced the incidence of septic complications but greatly reduced the severity and danger of these when present. The use of these valuable drugs during and since the Second World War has saved large numbers of lives and limbs

The type of suppurative arthritis now seen since the virtual elimination of streptococci and staphylococci by penicillin is due to Gram-negative organisms and resembles a subacute infective or proliferative arthritis. Further improvement in the results of treatment of knee-joint wounds depends upon the discovery of some means of combating *Bact coli* and *B. proteus* ("Wounds of the Knee-Joint," Burns, Young and Muller, *Lancet*, May 5, 1945.)

The necessity for early active movements remains if permanent stiffness is to be avoided.

(*c*) **Tuberculous Disease of Joints.**—The above remarks are inapplicable to tuberculous diseases of joints. Movement in such cases is associated with grave risk of exacerbation of the disease and of causing general dissemination. Absolute immobility of the tuberculous joint is therefore imperative while any signs of activity of the disease process persist. A sound ankylosis in the optimum position is a far more satisfactory end-result in tuberculous disease of a joint than a joint preserving a few degrees of weak and painful movement with the ever-present risk of a flare-up.

(*d*) **The Rôle of Movement in Chronic Rheumatic Diseases of Joints.***—It is difficult to have a better example of these principles than in the treatment of chronic arthritis, whether of the rheumatoid or osteo-arthritic type. What is the result of **complete** rest in these conditions? The synovial membrane and capsule undergo sclerosis, movement is still further obstructed by osteophytes developing at the articular margins, adhesion may occur between the articular surfaces in the rheumatoid types, there is secondary shortening of

* See also A G Timbrell Fisher, "A Contribution to the Pathology and Etiology of Osteo-Arthritis with observations upon the principles underlying its surgical treatment," Hunterian lecture, *Brit. Jour. of Surgery*, vol x, pp 52-80.

author recalls a case of suppurative arthritis of the knee-joint treated thus during the war of 1914-18, and which he was able to follow up. Two long lateral incisions were made for drainage, and the posterior compartments of the joint were also opened up by lateral incisions in the popliteal space. The joint cavity was periodically irrigated with eusol. In spite of every care, the patient's condition deteriorated, and it became obvious that unless amputation was performed, his life was in jeopardy. It was decided to try

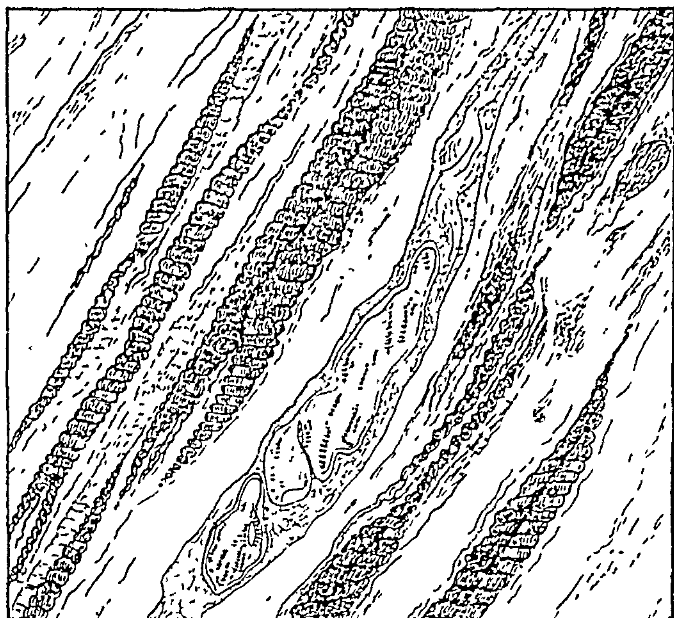


FIG. 11.—END-BULB OF NERVE BETWEEN TENDON FIBRES ATTACHED TO PATELLA

(Drawing by the late Dr Reginald Gladstone)

the effect of active movements of the joint. Although these were of necessity painful, the condition was explained to the patient and he loyally and intelligently co-operated. At the first movement there was a gush of pus from the drainage sites, and this was noticed at each subsequent movement. The patient recovered with a full and painless mobility. At a subsequent examination to demonstrate its excellent function, he hopped round the consulting room on the previously affected limb. If this case had been treated by complete rest under the conditions ruling in those days it is highly probable that amputation would have been necessary. The rationale

Prevention and Treatment of Deformity in the Earlier and More Acute Stages of the Rheumatoid Type of Arthritis.—The deformities that occur in this stage are at first due to muscular spasm and to gravity. It is usually found that flexion is a prominent feature, because the patient often finds this position of the affected joint to be that of greatest comfort. In other joints, such as the shoulder and hip, other deformities such as abduction, adduction, or rotation are combined with flexion owing to spasm of particular muscle groups. The joint apparently assumes the position in which joint pressure is least and which gives the greatest relaxation to the inflamed ligaments. In such early stages, if muscular spasm can be abolished, the deformities can be corrected with comparative ease. After a relatively short period, however, the deformities due to spasm become fixed owing to contracture of the joint capsule and peri-articular structures, and, in neglected cases, actual adhesion between the articular surfaces may occur by fibrous tissue or even by bone. The principles of treatment of the earlier stages may therefore be enumerated as follows:

(*a*) In the acute stages, when muscular spasm is prominent, every effort should be made to prevent deformity and to allay spasm by rest. Plaster casts are of great value for this purpose, and the technique of their application should be familiar to every medical man.

(*b*) Our ultimate aim should be, wherever possible, to preserve a movable and functionally useful joint. The possibility of ankylosis is, however, always present, so that the affected joint should be maintained in the **optimum position.** Some form of light and comfortable apparatus which can be easily removed for physical treatment and active movement is used for this purpose.

(*c*) When muscular spasm has already brought about deformed positions of the joints, these must be corrected at the earliest possible moment and before the deformities have become fixed. The accompanying table shows in adjacent columns the deformity which the untreated joint tends to assume compared with the corresponding optimum position.

Every effort must be made in recumbent patients to avoid faulty postures. Many neglected cases are seen where a prominent kyphosis has developed due to the patient being propped up with pillows. The hips and knees are frequently fixed in flexion owing to the bad practice of placing a pillow under the knees, and the pressure of the bed-clothes often causes the feet to be fixed in plantar flexion combined with valgus deformity. The nursing staff should be warned of these dangers, and particularly against the

tendons and other peri-articular structures, and the joint slowly but surely becomes more and more fixed, often in a position of gross deformity. Thousands of men and women exist who drag their stiff and deformed joints from one treatment centre to another, and whose condition might have been prevented by remembering the dictum that "movement is life." These deformities can usually be prevented by attention to three main principles, and it is unfortunate that many textbooks still speak of the stage of "sequels" as if the latter were inevitable. These principles are as follows:

1. The joint or joints should be put through the full range of movement daily, **although overexertion is to be avoided,** every effort being made to preserve the nutrition of the joint structures and to maintain muscular tone. This ideal policy is not always possible in the ultra-acute stages.

2. In most articular cases, particularly in the lower extremity, the principle of diminution of intra-articular pressure is to be observed by avoiding excessive weight-bearing or by some form of extension.

3. The cause must be simultaneously attacked. There is no greater mistake than to imagine that the rheumatic form of arthritis is necessarily a disease which steadily progresses. In many cases, all signs of activity cease, and it should be our endeavour so to act that when this happens the patient still retains a movable joint. The movements, in addition to preventing scarring of the soft parts, cause the osteophytes to develop in such a way that they do not interfere with movement. It is not sufficiently realised that, in many of these patients, the disease has come to an end and their symptoms are caused by the deforming stiffness. Treatment on "medical" lines by drugs, injections, etc., is of little benefit in such cases, for the stiff joint needs mobilisation. This can be restored by various physical and surgical measures, but particularly by manipulation, a most valuable procedure in suitable cases. The good results that are now being achieved at special rheumatism centres by the small band of enthusiasts who find rheumatic patients "interesting" are at last bringing home to the profession the great possibilities of modern therapy in this vital branch of medicine.

The following description applies principally to the treatment of the early stages of the more acute or rheumatoid type of arthritis. It is important to remember, however, that very similar principles are applicable to the more chronic or osteo-arthritic type of arthritis In the latter type the onset of deformity is apt to be very insidious and may easily be overlooked. Reference will be made to this aspect in a subsequent chapter.

TABLE OF TYPICAL DEFORMITIES OF JOINTS COMPARED WITH OPTIMUM POSITIONS FOR ANKYLOSIS (FIGS 12-23)

	Deformity	*Optimum Position for Ankylosis*
Hand	Ulnar deviation of fingers at metacarpo-phalangeal joints, excessive flexion at interphalangeal joints, sometimes hyperextension at proximal interphalangeal joints. Thumb adducted at carpo-metacarpal and flexed at metacarpo-phalangeal and interphalangeal joints	Absence of lateral deviation Moderate (about 25 degrees) flexion at metacarpo-phalangeal and interphalangeal joints of thumb and fingers Thumb moderately abducted, and opposed at carpo-metacarpal joint and continuing line of outer border of radius
Wrist	Flexion, drop wrist deformity.	Extension through 30 degrees.
Elbow	Usually midway between flexion and extension, forearm pronated	Varies to a certain extent according to occupation and patient's wishes In unilateral cases probably just below right angle—*i e*, about 70 degrees If both elbows may become ankylosed the second elbow should be fixed at a greater angle—say 110 degrees.
Shoulder	Flexed, adducted and rotated inwards	Flexion 20-30 degrees Abduction through 45 degrees in adults and 60-70 degrees in children External rotation 15 degrees
Foot	Hallux valgus or rigidus Pronation at mid-tarsal joint with consequent valgus deformity Flattening of anterior metatarsal arch with clawing of toes, which are often laterally deviated	Neutral position between inversion and eversion Maintain slight degree of flexion at metatarso-phalangeal joints and extension at interphalangeal joints
Ankle	Plantar flexed	Foot forms an angle of 90 degrees with the leg, 5-10 degrees of plantar flexion sometimes preferred.
Knee	Flexed and in severe cases the tibia is subluxated backwards and rotated outwards	Either complete extension or, when no shortening exists, 10-15 degrees of flexion may be advantageous
Hip	Flexion, abduction and rotation outwards in early stages Increased flexion with adduction and rotation inwards in later stages	Slight abduction (sufficient to compensate for any true shortening) Flexion through 20 degrees Neutral position of rotation
Spine	Flexion of neck with exaggeration of dorsal curve, lordosis or flattening of lumbar region Scoliosis often superadded	Maintenance of normal curves



FIG 12 —EXTREME DEFORMITIES OF THUMB AND FINGERS IN GONOCOCCAL ARTHRITIS

FIG. 13 —THUMB AND FINGERS OPTIMUM POSITIONS



FIG 16—TYPICAL DEFORMITIES IN ARTHRITIS OF ELBOW AND WRIST.



FIG 17—AN OPTIMUM POSITION FOR ANKYLOSIS OF ELBOW.



FIG 14 —TYPICAL DROP-WRIST DEFORMITY.

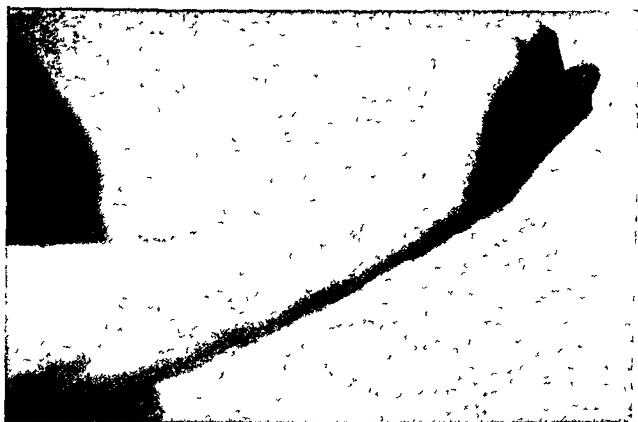


FIG 15 —WRIST OPTIMUM POSITION

practice of placing a pillow beneath the patient's knees. This gives a sense of comfort by relaxation, but in a short time, as Loring



FIG 20.

Stage 1 Apparent lengthening of right lower extremity



FIG 21

Stage 2 Apparent shortening of right lower extremity with slight flexion and external rotation Flexion is often completely masked by compensatory lordosis



FIG. 22

Stage 3 Real shortening of right lower extremity associated with increasing flexion and with internal rotation.

DEFORMITY IN CHRONIC ARTHRITIS OF HIP-JOINT (RIGHT)
x–x, Positions of anterior superior spines

Swaim* has pointed out, more flexion occurs and the supporting pillow becomes a permanent necessity. In fact it is the commonest

* Loring Swaim, "Prevention of Deformities of the Knee in Arthritis," *Journal of Bone and Joint Surgery*, October 1928, vol. x, No 4



FIG 18—ADDUCTION AND ROTATION INWARDS OF ARM IN LATE STAGES OF ARTHRITIS OF SHOULDER

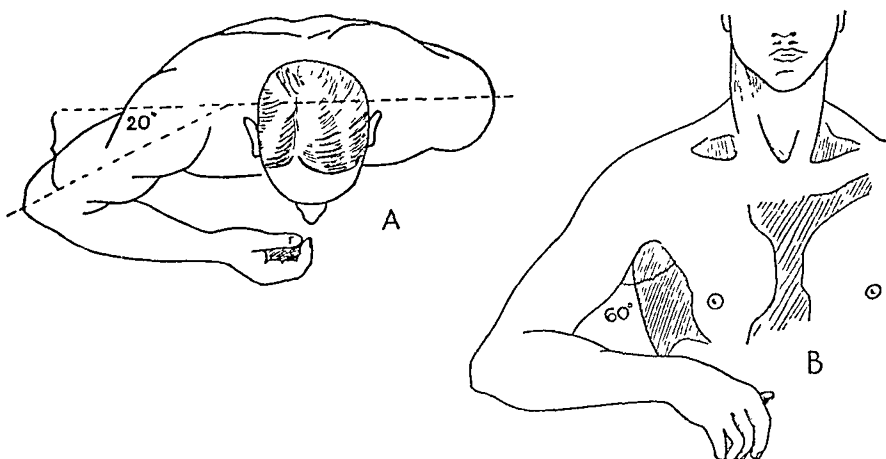


FIG 19—SHOULDER OPTIMUM POSITION.
(See Lee McGregor, *Brit Jour of Surgery*, vol XXIV, p 425)

The author has devised splints for both upper and lower extremities which may be used as an alternative method. They can be used repeatedly, are simpler and more rapid in their application or reapplication, and there is less risk of interference with the circulation of the limb.

The "Universal" splint for the joints of the upper extremity is constructed of duralumin and is fitted with special types of universal joint at shoulder and elbow which permit the shoulder or elbow to be fixed in any desired position (Fig 24). At the shoulder, for example, abduction, adduction, flexion and extension can be altered as desired. Extension is possible in both arm and forearm pieces by extension slides. The splint is applicable for arthritis affecting all the joints of the upper extremity, but the lower sections can be removed if necessary for application to the elbow and wrist.

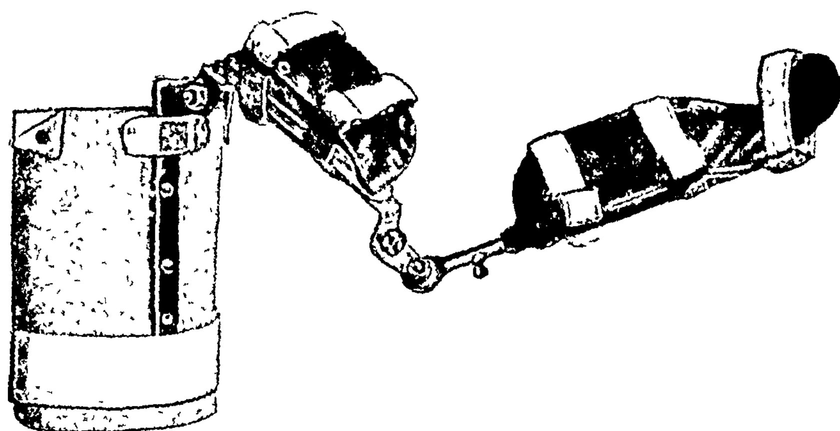


FIG 24—"UNIVERSAL" SPLINT FOR UPPER EXTREMITY.

The "Universal" splint for the lower extremity is constructed on somewhat similar principles and has been found valuable in the treatment of arthritis of the hip, knee, and ankle. An important feature is that the degree of flexion and extension at both knee and ankle and of abduction and adduction of the foot can be accurately adjusted.

Correction of Deformity in Early Cases of Arthritis by Methods of Weight Extension.—This is an alternative method and is sometimes of value, particularly in the case of the arthritic hip and when pain and spasm are marked. It is a method which requires close personal supervision, and it should be remembered that, unless applied in accordance with correct mechanical principles, it may cause increased pain and muscular spasm. In the hip, for example, extension must be applied in the line of the thigh. If the weight extension

cause of the initial flexion deformity and of the subluxation which may follow.

Various methods of splintage have been devised for the prevention of deformity and for its correction when due to muscular spasm. Moulded splints of plaster-of-paris which accurately fit the limb are by far the most comfortable and effective. This method requires care in its application, and the plaster splint should be "bivalved" early —*i.e.*, within twenty-four hours—so that no undue pressure is caused and the joint is made accessible for physical treatment and gentle assisted movements.



FIG 23.—DEFORMITIES OF LOWER EXTREMITIES IN CASE OF ARTHRITIS OF BOTH HIP-JOINTS

The affected joint should never be completely immobilised in plaster for a long period, as this is liable to cause ankylosis. Space will not permit a detailed description of the plaster-of-paris technique The principles of the method can, however, be quite simply stated Let us assume, for example, that we are dealing with the flexed arthritic knee. The limb is encased in plaster-of-paris bandages, no attempt being made to alter the angle of flexion of the knee. This is bivalved laterally within a few hours, so that the segments can be removed for effleurage or heat therapy or other forms of physical treatment. After a short period of rest in this position, it is usually found that spasm is so far diminished that a second plaster can be applied in an improved position This process is repeated until the position of deformity is completely rectified. Alternatively, a long plaster slab is moulded to the back of the limb and fixed in position by a circularly applied gauze bandage. This is re-applied as above, and, the limb not being completely encircled by the plaster-of-paris, there is less risk of interference with the circulation. Both padded and unpadded casts have their uses.

The results obtained by such early movements are much better than those following the long period of post-operative rest formerly practised. For a further discussion of this problem in relation to the knee-joint, reference is made to the author's "Internal Derangements of the Knee-Joint"

After operations such as arthroplasty or synovectomy, it is particularly important to begin early post-operative movements of the joint to prevent cohesion of the large denuded areas with resulting limitation of joint movement.

(*e*) **Early Movement in Injuries or Fractures involving Articular Surfaces.**—When an injury has caused a loss of substance of the articular cartilage, with exposure of the subjacent cancellous bone, the irruption of connective tissue from the exposed cancellous spaces is apt, in the absence of movement, to form a bond of union with the opposing articular cartilage If there is a corresponding loss of articular cartilage on the opposed surface, such adhesion is even more likely to occur Early active movements are important in such cases, and there is no evidence that such movements, however early, militate against repair of the articular surfaces The author has ascertained experimentally that after excisions of portions of the lower articular surface of the femoral condyles, followed by immediate movement, repair proceeds normally. He endeavoured to emphasise in a paper read at the Congrès International de Médecine et de Pharmacie Militaires held at Brussels that the principle of early movement applies with special emphasis to cases of gunshot wounds of the joints in which primary union without septic complications has occurred. Recovery with a useful range of joint movement is not impossible by taking pains and by careful surgery, and it is disappointing when a stiff joint results from unsuitable after-treatment. An important difficulty in such cases is the pain which is associated with such early movements, and the method that Leriche* uses to overcome this difficulty is to inject the articular ligaments and periosteum in the region of the fracture with novocain Active movements by the patient are then encouraged, but passive movements are forbidden. The novocain injections, followed by active movements, are carried out daily for two weeks, and then the patient can usually be relied upon to co-operate to the full in the further after-treatment

Burns and Young† point out that in many cases of fractures into joints the maximum displacement occurs at the time of the injury.

* Leriche, R , *Pr méd* , June 12, 1937, p 873

† Burns, B H , and Young, R H , "Early Movement in the Treatment of Closed Fractures," *Lancet*, June 3, 1944, p 723.

be applied in the line of the leg, interosseous pressure at the hip is increased, causing increased spasm of the psoas and iliacus and the development of lordosis Of recent years and with the improvement of plaster-of-paris technique, weight extension is only required in exceptional cases.

Similar principles are applicable to patients suffering from spondylosis ankylopoietica. In this disease, the need for prevention of deformity or for its correction in the earliest possible stages is urgent. There is no more tragic sight than an exaggerated kyphosis in this disease which has been fixed either by very dense adhesions or by a bridge of bone connecting the vertebræ. Deformity can be prevented or corrected in the early stages by the principle of extension by means of dorsal recumbency either in a plaster bed or on a special mattress or Bradford frame. Of these, an accurately moulded plaster bed is usually the most comfortable and efficient.*

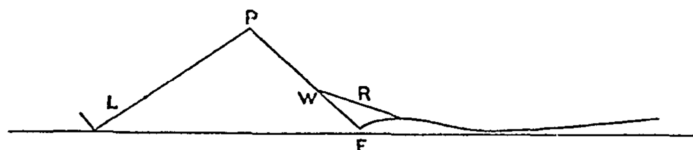


FIG 25 —DIAGRAM (AFTER HOWARD MARSH) SHOWING LORDOSIS PRODUCED BY INCREASED SPASM OF PSOAS AND ILIACUS (R) IF EXTENSION IS APPLIED IN THE LINE OF THE LEG (PL) INSTEAD OF THE THIGH (PF) IN ARTHRITIS OF HIP

The normal forward convexity of the lumbar spine must be remembered and undue flattening avoided.

(*d*) **The Rôle of Early Movements after Operations upon Joints.**—After such operations as removal of a semilunar cartilage, arthrotomy for loose body, synovectomy and arthroplasty, it is wise to encourage the patient to commence movements of the joint on the day following the operation, and in the case of the knee to contract the quadriceps at regular intervals throughout the day from the first After semilunar cartilage operations or simple arthrotomy of the knee, the patient is encouraged to walk never later than the seventh or eighth day, and some patients commence walking as early as the fourth or fifth day Special re-educational exercises are commenced on the seventh or eighth day, and the usual duration of stay in hospital or nursing home is twelve to fourteen days At the end of this time, many patients are able to walk without a limp.

* For technique of making a plaster bed and other plaster casts reference may be made to "Plaster-of-Paris Technique," by my colleague, F P Fitzgerald, in Pye's "Surgical Handicraft," fifteenth edition, 1947

treatment, and with the institution of fracture clinics or centres, on an appropriate scale, we may hope that the future will see an improvement in a situation which had hitherto not received adequate attention either from the medical profession or from national and local authorities.

(*g*) **Movements in Peripheral Nerve Injuries and in Injuries or Diseases of the Central or Peripheral Nervous System.**—Denervation is associated with trophic changes which may affect the whole limb, including the joints. Splints are usually necessary to prevent deformity, to relax the paralysed muscles and produce the optimum conditions for repair. These should, however, be removed periodically to permit gentle movement, to retain joint mobility and for electrical stimulation of the paralysed muscles. The same principle is applicable in many cases of anterior poliomyelitis and of hemiplegia. In poliomyelitis and many nervous disorders it is illogical to concentrate every effort on the return of nerve and muscle function and to allow the joints to get into the truly pitiable state so often seen. By ensuring that the joints are kept movable and free from deformity, with trophic changes reduced to a minimum, recovery is enormously expedited

If the displacement is slight there is therefore no need to immobilise the joint in plaster, and movements can start immediately. In cases where reduction is deemed advisable, this can often be achieved by internal fixation so that active movements can start at once.

In cases where correction is not considered possible, no useful purpose is served by immobilising the joint and here again active movements can start at once.

The principle of early movement in the case of fractures into joints associated with complete solution of continuity of the contiguous shaft is equally important, although to attain it sometimes taxes the mechanical skill and ingenuity of the surgeon to the uttermost. In the non-compound fractures into joints met with in civil life, the same early mobilisation may be permitted by operative fixation of the fragments in suitable cases.

(*f*) **Early Movement in Fractures not involving Articular Surfaces.**—Great attention is often paid to securing sound union in good alignment, but too little to the function of adjacent joints and muscles. It is sometimes overlooked that although the joints adjacent to the fracture may not themselves have been damaged, yet they often become soaked in sero-fibrinous exudate, due (*a*) to venous stasis and to disuse, (*b*) to recurrent œdema, (*c*) to infection, and this exudate may bring about troublesome adhesion formation. The value of Bohler's work lay in the fact that he evolved methods of immobilising the fracture and of limiting or preventing the sero-fibrinous exudate by accurately fitting plaster casts, and by early functional use of adjacent joints, thus reducing the liability to adhesion formation

It has been well said that every fracture department should have a framed text prominently displayed "*Bone and soft-part treatment are of equal importance.*" Of recent years there has been a reactionary movement in the direction of more and more immobility. Fractures of the femur are often treated on a Thomas splint for fourteen weeks, without knee-bending, and weight-bearing is sometimes not allowed in fractures of the tibia until firm union has occurred

The result in the case of the femur is often an obstinate stiffness of the knee which may never completely recover and in most cases requires a long and tedious period of re-education. It has been well said that the problem of the fractured femur is the problem of the fixed knee * If traction is applied, early knee movement is possible

With the more general recognition of modern principles of fracture

* *Ibid*

(*a*) Limitation of Movement.

The most obvious sign of the presence of adhesions is a certain degree of limitation of movement. Often this limitation is obvious, and may be associated with actual **deformity.** In others, however, the limitation may be slight, and easily overlooked, unless examination be careful and systematic. Definite limitation of some joint movement may also be masked by compensating movements elsewhere. For instance, a marked degree of limitation of abduction of the hip may be completely masked by movement of the pelvis, and unless this pelvic movement is recognised it might be erroneously assumed that the range of abduction of the hip was complete. Similarly, marked stiffness of the shoulder-joint may be masked by scapular movement. Therefore, in assessing the range of movement of the hip or shoulder-joints, the pelvis and shoulder-girdles respectively should be fixed. The importance of an accurate knowledge of all the movements of joints, particularly of those that are less obvious, can scarcely be over-estimated. For this reason, a short account of the surgical anatomy and of the movements of individual joints will be given in the ensuing sections before the appropriate manipulative technique is described.

We now come to a point of considerable importance. How are we to distinguish between limitation of movement due to some acute condition of a joint in which manipulation is contra-indicated and limitation of movement due to adhesions? In the first place, we find not only raised surface temperature over the joint which is the seat of active and progressive changes, but nearly always a limitation of all the joint movements, and pain and muscular spasm are elicited by these from the first. Secondly, we find in the otherwise healthy joint incapacitated by adhesions that the majority of the joint movements may be comparatively free and painless, but that some particular movement or movements are limited, and yet these up to a particular point may be free and painless. The restriction of range of movement varies within wide limits, and there should be no difficulty in distinguishing restriction due to this cause, with its elastic sense of resistance, from that due to bony obstruction. The latter is usually self-evident, although cases commonly occur in which the limitation is due partly to adhesions and partly to bone. This combination, as we shall see later, often occurs after fractures, and in chronic arthritis of the osteo-arthritic type. It may sometimes be observed in this disease that movement is markedly restricted, and an X-ray of the joint

CHAPTER IV

DIAGNOSIS OF ADHESIONS

It is important to recognise the signs and symptoms of articular adhesions, particularly when the patient is making no headway under physical treatment, because it is so often possible to bring about a rapid cure of the condition by manipulation and thus rescue the patient from indefinitely prolonged disability

Adhesions may give rise to a variety of signs and symptoms In some joints, the functions of which are interfered with by adhesions, all the signs and symptoms to be described in this chapter may be present In many cases, however, some particular sign or symptom may be a prominent feature, others being either absent or of minor importance.

It is a wise plan, in the approach to any injury or disease of a joint, to conduct the examination in a systematic way

- (*a*) Examine every component of the joint both at rest and during movement.
- (*b*) In unilateral cases compare with the opposite side
- (*c*) Investigate the condition of the other joints
- (*d*) Examine the whole patient.

Much can be learned by careful observation of the joint ("Eyes first and much"—Sir George Humphry) and of the muscles which act upon it and by observing the range of active movement By palpation we confirm or modify the evidence of the eyes, and may learn many important additional facts. In every case we must ascertain the condition of the articular ends, both bone and cartilage, the ligaments, capsule and synovial membrane The peri-articular structures are examined, including skin, subcutaneous tissues, tendons and their sheaths and bursæ The presence or absence of fluid in the joint is noted, as is also the range of movement, both active and passive. Is movement of the joint painful and, if so, are all the movements painful or only certain movements? Is there crepitus on movement and does abnormal mobility exist in any direction? Accurate measurements must be taken to ascertain whether muscular wasting is present, and muscle tone is tested

Finally, X-rays, particularly stereoscopic, may give valuable information.

a complaint of sudden " giving-way " or loss of power in the affected limb, which may cause the patient to fall down or to drop anything that is being carried. These attacks are probably due to reflex muscular inhibition from sudden stretching of adhesions. In other words, a complaint of weakness often means that those movements which pull upon adhesions are instinctively avoided because they are painful. A good example of this symptom is seen in the type of " tennis elbow " due to adhesions, where such simple actions as lifting a cup of tea are often rendered difficult by the sensation of weakness and loss of power.

Adhesions in connection with the knee are a frequent cause of a feeling of weakness or of actual " giving-way " of the knee.

(*d*) Tenderness.

This is an important feature of adhesions, probably owing to the fact that the constant drag to which they are subjected keeps up active inflammatory changes in them, and also at the site of their proximal and distal attachments. One or more localised points of tenderness in a joint in which, from clinical grounds, the presence of adhesions is suspected constitute important diagnostic aids. In every joint, as we have seen, there are sites of election for adhesions, and the tender spots correspond as a rule with these sites.

Some of the principal sites in individual joints where tenderness due to adhesions is commonly present are as follows:

1. *Hip-Joint*—Over the head of the femur in the centre of the groin, corresponding to the ilio-femoral ligament, or over the posterior aspect of the joint on deep palpation in the gluteal region. Owing to the deep-seated position of the hip-joint, tender points are often difficult to discover and have not the same significance as elsewhere.

2. *Knee-Joint*—Inner aspect of joint over middle of inner surface of internal semilunar cartilage, opposite attachment of deep fibres of internal lateral ligament. Front of joint over infrapatellar pad of fat.

3 *Ankle-Joint.*—Below and in front of external malleolus of fibula, over the anterior fasciculus of the external lateral ligament. also over extensor tendons on anterior aspect of joint.

4 *Flat Foot*—Region of tuberosity of scaphoid.

5. *Metatarsalgia.*—Pressure over under-surface of head of third or fourth metatarsal bones. In true Morton's metatarsalgia pain is often felt on lateral compression of the heads of the metatarsal bones.

may reveal well-developed osteophytes, yet it is surprising to find in many cases, when such a joint is examined under an anæsthetic, how little of the limitation of movement is due to the osetophytes present. An examination under anæsthesia should therefore usually be performed before deciding upon any such operation as the chiselling away of osteophytes, which are alleged to be causing interference with motion. We may conclude by making the somewhat paradoxical statement that those cases in which the presence of adhesions is apt to be overlooked are the very ones in which manipulation is often of the greatest benefit. The actual degree of interference with movement, due to adhesions, is nearly always increased by muscle spasm caused by any movement which stretches these adhesions

(*b*) **Pain.**

It is characteristic that when an adhesion is stretched, pain is experienced The patient thus learns to avoid the movements that give rise to such stretching and pain. Consequently, the muscles that bring about this movement or movements waste and lose their normal tone, and those that prevent such movements usually present tonic spasm, and may in time undergo adaptive shortening. This tonic spasm may in itself be painful, and must be abolished by massage, by some special movement, or by anæsthesia, before the adhesions can be satisfactorily treated.

A common symptom of adhesions is nocturnal aching, which interferes with sleep It is probable that the muscles are on guard during the waking hours to prevent stretching of the adhesions. During the muscular relaxation of sleep, however, they are apt to be dragged upon, with consequent pain.

It is important to remember that pain may be felt, not only in the joint itself, but in the distribution of the nerves which supply it For instance, many cases of "brachial neuritis" are associated with adhesions in or around the shoulder-joint, and manipulation of the latter may cure the "neuritis" "Sciatic pain" is also frequently associated with adhesions in the lumbar, lumbo-sacral, sacro-iliac, or hip-joints

(*c*) **Muscular Wasting and Loss of Power.**

In nearly every case, disuse atrophy of certain of the muscles activating the affected joint may be noted Loss of power is mainly due to the wasting and loss of tone mentioned, and in some cases to laxity of ligaments from recurrent effusions. There is often

invaluable in orthopædic work, and in the case of the joints of the limbs, comparison should always be made with the opposite side.

Symptoms of internal derangement at first considered to be due to adhesions may be shown to be due to loose bodies, where manipulation would be futile.* The radiograph may show marked destructive changes in the articular ends, where manipulation would be of doubtful utility. It may show the typical features of neoplasm, tuberculous disease, or myositis ossificans, or of a chronic abscess near the joint, in all of which manipulation would be absolutely contra-indicated. Radiography of the spine is a *sine qua non* before any manipulation of the back to avoid the tragedy of manipulating a tuberculous spine, or one which is the seat of a primary or secondary malignant growth. A lateral or oblique view of the spine should not be omitted, as this often gives valuable information not obtainable in the antero-posterior view. "Quiet" tuberculous disease of the spine may be very deceptive. A trapeze artist complained of slight pain in the lumbar region after a fall. Although only a few weeks had elapsed since the accident, advanced tuberculous disease of the lumbar spine was present, and it was clear that this patient had been able to carry out her dangerous occupation for a considerable time in spite of this serious condition.

X-ray examination of a joint after preliminary injection of air or oxygen may demonstrate the existence of adhesions (Fig. 26).

Tuberculous Disease.

There is rarely any real difficulty in excluding most cases of stiff joint due to tuberculous disease, if careful investigation be made into the history, symptoms, and physical signs. In a minority of cases, however, diagnosis may be very difficult. Monarticular forms of the rheumatoid type of arthritis of the knee, for example, may simulate tuberculous disease very closely. In this connection it is of interest to note that, in the opinion of some Continental rheumatologists, rheumatoid arthritis is a tuberculous manifestation A stiff joint in a child should always arouse our suspicions. In fact, swelling and loss of function and not pain are often the first symptoms. The patient may have a significant family history, or may present other signs of the disease. There may be some loss of health

* The correct treatment for loose body in a joint is, of course, removal. Occasionally the attacks of locking may temporarily cease when the loose body moves to some region of the joint where it cannot stray between the joint surfaces It is within the bounds of possibility that such temporary dramatic relief might follow a "bone-setting" operation

6. *Shoulder-Joint.*—Pressure over front of joint (tip of coracoid process), over posterior and inferior part of joint, or over subdeltoid bursa.

7. *Elbow-Joint.*—Pressure over apex of internal lateral ligament at its attachment to internal condyle of humerus, or on posterior aspect of joint below external condyle. In "tennis elbow," localised tenderness is frequently present over the tip of the external epicondyle of the humerus, or over the antero-external aspect of the superior radio-ulnar joint.

8. *Wrist-Joint*—Pressure over middle of wrist anteriorly and posteriorly, or over inferior radio-ulnar joint.

9. *Sacro-Iliac Joint.*—Pressure over postero-superior spine of ilium.

(*e*) Recurrent Effusion.

Although this sign is present in other conditions affecting joints, it is frequently encountered in cases of articular adhesions, particularly when the knee, ankle or wrist are involved. A common sequence of events is as follows A joint, such as the knee, receives some injury which causes synovitis and effusion Complete rest is ordered until effusion has subsided The patient is then allowed to get up and exercise the limb This results in further effusion, rest is again prescribed, and the process is sometimes repeated for many months. In the meanwhile, owing to lack of use, muscular wasting, often of a marked nature, ensues, and a vicious circle is thus formed In many such cases the practitioner has become alarmed and has suspected tuberculous disease The presence of such recurrent effusion, when due to adhesions, is usually a sign of some defect in the treatment of the original injury.

Differential Diagnosis.

Under this heading, it is of the utmost importance to differentiate between cases in which manipulation is indicated and other conditions, leading to painful limitation of movement of a joint, in which manipulation is futile or dangerous. Of the latter, the principal are tuberculous disease of a joint, myositis ossificans, cases of firm fibrous ankylosis and joints that are the seat of active inflammation.

X-Ray Examination.

Radiography is often a valuable aid before manipulation is performed. With rare exceptions, it is a wise plan always to insist on a prior X-ray examination Good stereoscopic X-rays are

membrane, the raised temperature over the joint, especially after exercise, the very marked wasting that is usually present, and the



FIG 27 —TUBERCULOUS DISEASE OF KNEE-JOINT.
(Radiograph kindly lent by Dr H K Graham Hodgson, M V.O)

generally more marked severity of the symptoms, all serve to distinguish tuberculous disease from traumatic synovitis. The marked wasting of the muscles activating the affected joint seen

and vigour and general malaise. The history of gradually increasing disability bearing no very direct relation to an injury, or following an injury at some considerable interval, is very different from that given



FIG 26 —AIR ARTHROGRAPHY OF KNEE-JOINT.

in traumatic synovitis, in which the connection can in most cases be directly traced. The somewhat spindle-shaped nature of certain tuberculous joints, with the pulpy thickening of the synovial

be pointed out that effusions due to various chronic infections and to trauma may show local elevation of temperature, but this tends to disappear much more rapidly than in tuberculosis of a joint. De Quervain states: "Every mono-articular, chronic serous inflammation of the knee, wherein there is definite thickening of the reflected folds of the capsule, and wherein there is a persistent definite local elevation of temperature, must be regarded as tuberculous even if mobility still remains free and pronounced muscular atrophy is absent. Nothing but very clear evidence to the contrary warrants us in departing from this rule of diagnosis." In cases in which the tuberculous process has attacked the articular ends a good radiograph is a particularly valuable aid, and should never be omitted (Figs. 27 and 28). Unfortunately, although a positive radiograph is valuable evidence, a negative in the early stages does not exclude the possibility of tuberculous disease. Clinically, in these cases the presence of starting-pains is often superadded. In a difficult case, and particularly in children, certain special tests are sometimes of value, such as the cutaneous reaction of von Pirquet and the intradermic test of Mantoux For particulars of these tests, the appropriate medical works should be consulted.

As, under modern conditions of civilisation, few of us escape minor degrees of infection by the *Bacillus tuberculosis*, it should be noted that a negative is of far greater significance than a positive reaction.

When synovial effusion is present, a valuable test is to withdraw some of the fluid under strict aseptic technique and inject into a guinea-pig. In positive cases the animal dies of generalised tuberculosis in six to ten weeks.

Histological examination of portions of tissue from the joint, obtained by exploratory arthrotomy, is seldom applicable to those in which manipulation is under consideration. This procedure has also the disadvantage of introducing the risk of secondary infection. The general consensus of opinion is that diagnostic arthrotomy is apt to be followed by septic troubles and the formation of a troublesome sinus. Furthermore, that it is free from risk only if a positive diagnosis of tuberculosis will be quickly followed by a fusion operation.* Biopsy of an inguinal gland in suspected tuberculosis of a joint of the lower extremity has its advocates.†

The cases which present the greatest difficulty are those in which the disease has become quiescent, and has left the patient with a stiff

* See G. R Girdlestone, "The Pathology and Treatment of Tuberculosis of the Knee-Joint," *Brit Jour of Surgery*, January, 1932, p 488

† Seddon, *Brit Med Journ*, January 21, 1939

in many diseases of the articulations, such as the rheumatoid type of arthritis and tuberculosis, is in part due to disuse. There can be little doubt, however, that this is not the complete explanation Vulpian, Paget, Charcot and others considered that the condition was in part reflex and that impulses pass from the joint to the nerve cells in the anterior cornu of the spinal cord. There is a striking similarity in the wasting that occurs in many cases of the

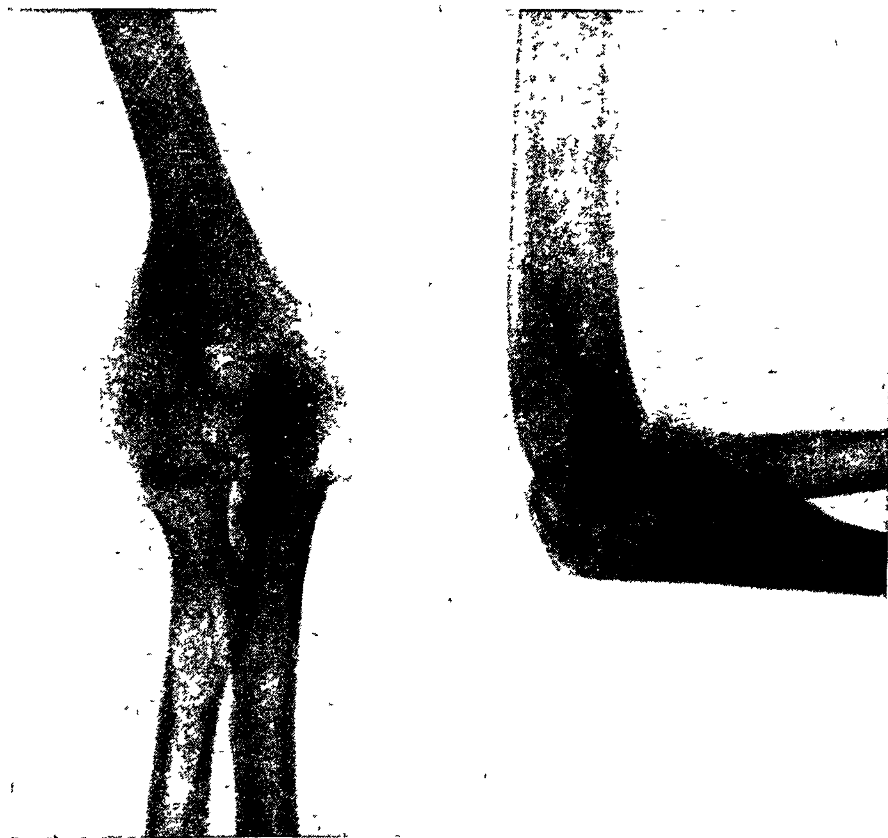


FIG 28 —TUBERCULOUS DISEASE OF ELBOW

rheumatoid type of arthritis and that seen in poliomyelitis The muscular atrophy is not only peculiarly selective but occurs more rapidly than can be accounted for by mere disuse Synovial thickening occurs in other diseases, but the uniformity of the swelling and its doughy feeling are characteristic of tuberculous disease; moreover, the wasting is particularly rapid in onset. With regard to the raised temperature over the joint, it should

CHAPTER V

MANIPULATIVE TREATMENT: GENERAL PRINCIPLES

THE cure or alleviation by manipulation of various disabilities, often of an obstinate nature, depends upon a delicacy and sensitiveness of touch which is to a certain extent inborn, although it can be greatly increased by training and continuous practice. As the history of bone-setting shows, these gifts are often inherited, but it is a serious error to assume, as do many members of the public, that unqualified practitioners have any monopoly of the necessary gifts. Skill in manipulative work cannot, moreover, be learned from books alone or by watching experts at work.

To give an example from the world of sport, no person would be so foolish as to suppose that a concentrated study of books upon technique or the mere watching of accomplished players is sufficient for outstanding success in such games of skill as golf or cricket. In these, as in manipulative work, assiduous practice is of paramount importance. In both spheres, constant practice is, however, no guarantee of success if the inborn qualities mentioned above are lacking. A good rider is sometimes said to be gifted with "hands"; an asset that some who have been riding for a lifetime never seem to acquire.

Success in manipulative treatment depends, moreover, not only upon the factors mentioned above, and upon the technique employed, but upon a careful selection of cases and knowledge of the most suitable period at which to perform manipulation.

The use of extreme force even in the case of the foot* is never necessary, and may lead to injury to bones, muscles, bloodvessels, nerves, or other important adjacent structures When the adhesions are so dense that extreme force would be necessary, manipulation is contra-indicated, although open operation either alone or combined with manipulation may be of benefit. Even if damage to adjacent structures could be ruled out of court, the severe reaction caused by the rupture of dense adhesions usually results in re-stiffening of the joint and a disappointing result. Furthermore, a considerable degree of shock may be caused, particularly in elderly persons, by such misguided treatment

It is usually desirable to wait for a quiescent period before

* This particularly applies to manipulation of the foot in cases of arthritis of the rheumatoid type, where the bones are often atrophic. A powerful man who had read that it is impossible to apply too much force in manipulating the foot might easily reduce the foot to a pulpy mass of broken bones!

joint. Many of the symptoms and signs mentioned above will be absent, tests of doubtful utility, and reliance is placed principally upon the following

(*a*) A careful history of the case.
(*b*) Thorough examination of the patient for other tuberculous signs and symptoms, including radiography of the chest
(*c*) The radiographic appearances of the joint (often ambiguous).
(*d*) The usually marked wasting.
(*e*) The presence of scars of old sinuses.

In such cases, tubercle bacilli may be imprisoned in the areas of scar-tissue, and manipulation may be followed by disaster.

For further details of the above-mentioned and other special tests, textbooks on pathology should be consulted.

The question of tuberculous disease in differential diagnosis has been stressed in this chapter because it arises most frequently. Other important contra-indications to manipulation will be mentioned in the next chapter and in Chapter X

actual manipulation, and demands a knowledge of the principles of physical treatment. In fact, to avoid disappointment it should be explained to the patient that the manipulation constitutes only the first stage of what may prove to be a somewhat prolonged course of treatment.

After the restoration of movement to a stiff joint by manipulation, the joint must either immediately or at the earliest possible moment be again moved through the increased range, and this movement must be kept up subsequently at regular intervals to ensure success. This after-treatment is particularly important in the second type described above to prevent any tendency to recontracture. The wasted muscles must also be made to recover by appropriate re-education. This entails that at the earliest possible moment, and even in many cases immediately on coming round from the anæsthetic, the patient should be encouraged to perform exercises by which the increased range of movement obtained by the manipulation is consolidated The surgeon who performs the manipulation should take a personal interest in the after-treatment and see the patient at regular intervals. Complete responsibility for the after-treatment must never be delegated to the physiotherapist: the surgeon must give definite instructions to the latter and see that they are religiously carried out. The responsibility for the complete rehabilitation of the patient is his alone. Definite instructions must be given to the physiotherapist not to waste valuable time in massage, but to concentrate practically the whole session upon re-educational exercises.

It sometimes happens that, if specific instructions are not given, almost the whole session is devoted to massage and electrical stimulation of muscles and perhaps five minutes at the end to the vitally important re-educational exercises

Although faradic stimulation of wasted muscles is not without use in certain cases, it has a limited application after manipulations of joints; in fact one good active contraction of a muscle, such as the quadriceps extensor cruris, is of more value than many contractions produced by electrical stimulation.

The frequent co-existence of a functional element must always be borne in mind The importance of firm, but kindly, handling and of inspiring confidence and keen co-operation in the patient can hardly be over-estimated.

It has been well said that every member of the team must make at least two contributions: the exercise of professional skill, and of a cheerful, confident personality which so inculcates the will to get well that apathy never develops. The combination of these qualities

performing manipulation. This particularly applies to cases of limitation of movement occurring in chronic arthritis. If the condition is still active, as evidenced by signs of obvious inflammation, including a raised sedimentation rate, or by the recent onset of arthritis in other joints, manipulation should be deferred until the acuteness of the symptoms has subsided We must bear in mind, however, that in synovitis, acute exacerbations may be due to the presence of adhesions, and if we are convinced that these are present, we must not hesitate unduly before having recourse to manipulation.

It is fundamentally wrong to assume that the art of manipulation merely consists in restoring the full range of movement of a joint and in using brute force to achieve this Special technique, usually involving a twisting movement, which the patient cannot normally perform, has to be learned for each joint The technique suitable for individual joints will be described in the following chapters

As a general rule, it may be stated that the results of manipulation vary according to the degree and strength of adhesions and the force necessary for their disruption—viz., the cases in which but little force is necessary, and in which adhesions are slight, are attended with the best prognosis.

In difficult cases, it is wise to exercise patience and be content with achieving the desired result by a carefully planned series of manipulations, separated by intervals of ten or fourteen days, rather than run the risk of exciting severe reaction and shock by attempting too much at one operation

The mere stretching of adhesions is less effective than actual disruption, for although temporary improvement may result, the stretched adhesions tend to recontract and shorten, although this can be largely prevented by careful after-treatment In cases of slight adhesions, rapid movement with a long leverage is indicated, whereby the adhesions are ruptured. To avoid subsequent reaction, the appropriate movements should be carried out promptly and in a purposive manner, and when our object is attained and movement is restored, any further movements are unnecessary When, however, adhesions are more dense, movements of a slower and more deliberate nature, with shorter leverage, are less likely to cause fracture, and such movements bring about gradual stretching rather than rupture of the bands of scar-tissue

Special treatment after manipulation is essential, particularly in those cases in which a marked degree of stiffness has been present. In the latter, and especially in many stiffened arthritic joints, the after-treatment may be of equal or even greater importance than the

It is preferable that a patient who is to be given this anæsthetic should be admitted into hospital or nursing home for at least two nights, one before and one after the manipulation, so that he or she shall be adequately prepared beforehand and completely recovered after the operation This rule may be waived, however, when a minimal amount of pentothal is given for a short manipulation.

The usual premedication between 16 and 65 years of age is omnopon gr. $\frac{1}{3}$ and scopolamine gr. $\frac{1}{150}$ injected hypodermically one hour before operation, extremes of age and frail patients receiving half the dose (omnopon gr. $\frac{1}{6}$ and scopolamine gr. $\frac{1}{300}$), children receiving atropine only gr. $\frac{1}{100}$.

For short manipulations, 0·5 gm. of pentothal sodium in 10 c c. sterile distilled water (5 per cent. solution) gives an adequate degree and length of anæsthesia in a large proportion of subjects, but for longer procedures or robust patients, up to 1·0 gm. may be used but never in greater strength than 5 per cent.

Pentothal sodium is supplied in an ampoule as a white powder, and the distilled water in the required amount in a separate ampoule. The contents of these two ampoules are mixed in the syringe, which has been thoroughly sterilised either by boiling, or if all glass, autoclaved.

The pentothal solution is not stable if exposed to the air for some time, and so it should always be freshly prepared.

Method of Administration.

A suitable superficial vein is sought, and can usually be found in the antecubital fossa, or in the hand or foot A rubber band is then placed around the limb proximal to the vein chosen, and pulled tightly enough to prevent venous return.

The needle is now inserted into the vein and the plunger of the syringe withdrawn a little to verify that the needle is in the vein. The band is then undone and the patient asked to count aloud slowly, 4 or 5 c.c. are injected in 10-15 seconds and more added if necessary, until the patient is unconscious. After this, injection is made 1 c c at a time until the required relaxation is achieved. During this proceeding respiratory depression occurs and a clear airway must be constantly preserved.

If the anæsthesia produced by the full 20 c.c. pentothal solution does not last long enough for the operative procedures, it may be prolonged by the inhalation of N_2O+O_2 with the addition of Trilene, which, although alone in safe doses does not produce muscular relaxation, has proved in these cases to give very efficient prolongation of relaxation.

is one of the most important, if not indeed *the* most important, factor in rehabilitation.*

When movement, instead of being increased, is actually lessened by manipulation, or if severe pain and reaction follow, it is evidence either that the case was unsuitable for this form of treatment, or that methods were seriously at fault.

As a general rule, it may be stated that cases of minor degrees of stiffness due to adhesions may often be cured by such forms of physical treatment as heat, in its various forms, massage, and exercises. In marked cases of limitation of movement by scar-tissue, these measures rarely suffice to regain complete range of movement. In minor cases, therefore, and if time permits, it is usually advisable to give these forms of physical treatment a preliminary trial, and if they do not bring about a complete cure, the subsequent manipulation is facilitated. Such physical measures should never be persisted in if progress is slow. If an adhesion can be broken down in a few seconds under anæsthesia, no useful purpose is served by submitting the patient to a lengthy and perhaps expensive course of physical treatment.

Anæsthesia in Manipulative Operations.†

For successful manipulation complete muscular relaxation is necessary. Some form of anæsthesia is therefore desirable which can be maintained at a deep level for a short time. Minor manipulations can, however, be carried out under nitrous oxide anæsthesia alone, and rapid recovery of consciousness permits of immediate re-education. If, however, this method has been chosen and the relaxation proves inadequate, ether and/or trichlorethylene (Trilene) may be added. Local anæsthesia has proved as a rule unsatisfactory, as it is often difficult both to abolish pain completely and to produce the degree of muscular relaxation necessary for successful manipulation.

Injection of novocain or of some other cocaine derivative may be used if the patient demands a local anæsthetic, and for minor manipulations in which the site of tenderness is very localised as in some cases of tennis elbow

The anæsthetic of choice, however, is the intravenous injection of one of the barbiturates, pentothal sodium giving a greater degree of relaxation than evipan sodium and others.

* H. Osmond Clarke, "Orthopædic and Rehabilitation Service of the Royal Air Force," *Lancet*, May 18, 1946, p 721.

† For this section I am indebted to my colleague, Dr M E. Williams

difficult type of case than that in which the condition accrues to the patient's financial advantage, as in many compensation cases and in the majority of pensioners. Only very exceptionally can any lasting improvement be expected in such patients—at any rate, while their claims are pending settlement. Compensation in the form of a "lump sum," if reasonably adequate, is often followed by recovery and return to work.

Manipulation in Chronic Rheumatic Conditions.

In 1924 appeared a Report of the Ministry of Health into the Incidence of Rheumatism which aroused widespread interest. It revealed that this disease accounted for an enormous amount of sickness and loss of time in industrial workers and that the disbursements in sick benefit for this disease amounted to millions of pounds annually. The medical profession and more enlightened members of the public were stirred by these revelations, and since the publication of the Report there has been a marked growth of interest in this vital national problem, which led to the formation of the Empire Rheumatism Council in 1936.

Among the principal objects of the Council are the stimulation of public and governmental interest, so that modern treatment which is now denied to multitudes of sufferers may become more generally available, the encouragement of research into causation; and the formation of special treatment centres in all parts of the Empire In 1941 was published "Rheumatism: A Plan for National Action," by Lord Horder, assisted by members of the Empire Rheumatism Council, and this was another important milestone * It was followed by a declaration by the British Government that lack of facilities for suitable treatment of rheumatic sufferers would be ended as soon as war obstacles were removed A recent favourable development with great possibilities for further progress has been the formation of a joint sub-committee of the Empire Rheumatism Council and the British Orthopædic Association to develop co-operation between the two bodies

In arthritis of both rheumatoid and osteo-arthritic types, limitation of joint movement and deformity are particularly liable to follow. The orthodox treatment formerly consisted in use of the joint up to the limit of pain, and in protection of the joint from further movement by apparatus. Experience, both clinical and experimental, throws doubt upon the soundness of this

* "Rheumatism A Plan for National Action," by Lord Horder (H K. Lewis and Co, Ltd).

It is possible that curare, a drug which given intravenously paralyses the neuro-muscular junction and so produces complete paralysis of the voluntary muscles *without* anæsthesia, may in the near future (when dosage, etc , have been fully worked out), with the addition of a very light inhalation anæsthetic, prove an even more useful addition to the manipulative surgeon's agents for producing short and complete relaxation.

Spinal anæsthesia is occasionally of value for manipulation of the lower extremities, particularly in cases of sciatic pain

Manipulation in Functional or Hysterical Conditions of the Joints.

This large and important group may, as we have observed (p. 25), be subdivided into several classes, the most important of which are

1. Cases that are purely functional.
2. Cases in which a functional element is associated with an organic basis.

The medical man must never forget that these persons have, in all probability, previously consulted many others, both qualified and unqualified, and that entire faith is now pinned upon him. He must prove himself worthy of this trust, remembering that, owing to the peculiar state of the patient, some trivial thing may change trust into mistrust, and the golden opportunity is lost for ever He must take his courage in both hands, and by a judicious combination of tact, sympathy, firmness, and determination, snatch victory out of the jaws of failure. Organisation and personal attention to the smallest detail by each member of the team are essential.

An important principle in this type of case is that immediately the patient has regained consciousness after the anæsthetic, he or she must be firmly convinced that the previously " paralysed " limb or fixed joint can now be freely moved, and the surgeon must not leave the patient until he has made the latter voluntarily perform the said movements Re-education must next be carried out regularly, but this must not be of such a nature as again to fix the patient's mind in an abnormal manner upon the joint or limb In many cases, indeed, the best form of re-education consists in some healthy open-air sport or occupation, by means of which the limb is exercised and put through its movements unconsciously while the mind is concentrated upon the game or work.

Prognosis is influenced by two very important factors. The first consists in the length of time that the condition has existed When this is a matter of many years, the prognosis is considerably worse than when the period has been short. Secondly, there is no more

The method to be adopted in any individual case requires careful consideration. Cases of firm fibrous or of osseous ankylosis if in a poor position are better treated by open surgical operation; for if manipulation be performed, there is grave risk of fracture, of injury to other important structures, or of serious shock. The procedure, moreover, is futile, as considerable reaction is excited and the joint promptly restiffens.

Cases of pathological dislocation in rheumatic forms of arthritis may sometimes be corrected or considerably improved by weight extension. My colleague F. P. Fitzgerald has described (*Brit. Med. Jour.*, November 7, 1942, vol. ii, p. 542) a case of rheumatoid arthritis of the right knee in a man of fifty-six, in which pathological

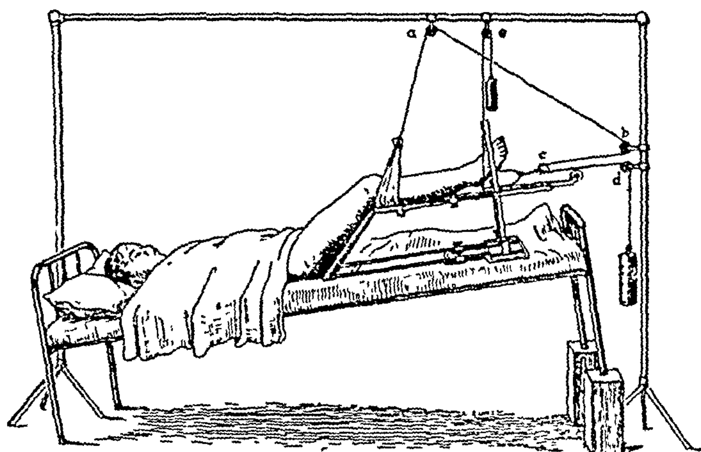


FIG 29—WEIGHT EXTENSION FOR CORRECTION OF PATHOLOGICAL DISLOCATION OF KNEE

dislocation had occurred eighteen months previously and which was completely rectified by this means in seven weeks.

The hip was placed in an adjustable Braun splint, so that traction could be exerted in the line of the deformity (Fig. 29). Skeletal traction was applied through the os calcis, so that the external rotation could be controlled A sling was passed under the knee and attached to a cord which passed over a pulley (*a*) on a Balkan frame. Then it was continued to another pulley (*b*) on the vertical limb of the Balkan beam at the level of the leg A third pulley was fixed to the Bohler stirrup on the os calcis nail (*c*) and a fourth (*d*) tied to the upright just below (*b*). The cord was then threaded over these and finally attached to a weight of 7 lb. The foot of the bed was elevated A cord was fixed from the outer side of the nail to a

teaching. What is the cause of such limitation of movement? The answer is, in most cases, adhesions or scar-tissue, in others, enlarged synovial processes or fringes, and sometimes it is due to the presence of osteophytes. It is claimed that if the painful movement is restricted for some time it will eventually become painless A commoner sequence is for adhesions to become more dense, and for the limitation of movement to become permanent. For instance, in many rheumatic forms of arthritis of the knee there is a painful limitation of extension due to adhesions or shortening of the flexor tendons, and not infrequently a knee-cage is prescribed with a stop to prevent full extension. But walking with a semiflexed knee disturbs the mechanics of the lower extremity and spine and may cause chronic strain or the development of rheumatic symptoms in these regions The correct treatment is to overcome the limitation of extension either by manipulation or open operation, whereby the mechanics of the limb are restored and the instrument can be discarded

Prevention of Deformity.—During the more acute stages of the rheumatoid type, and in many cases of the osteo-arthritic type, muscular spasm is a prominent feature, and, owing to the selective spasm of certain muscular groups, deformity is apt to occur Every effort should therefore be made during this stage to prevent such deformity

A discussion of this aspect will be found in Chapter III

Treatment of Chronic Arthritis by Manipulation.—Under this heading it will be convenient to discuss cases of the rheumatoid type, originally acute or subacute, which have become chronic, or cases of the osteo-arthritic type, in all of which "fixed" deformity has occurred

As a rule, an attempt should always be made, provided the age, general condition of the patient and other circumstances are favourable, to remedy deformity when it is a cause of discomfort or pain, or when it interferes with function In the rheumatoid type, the stiffness is usually a form of fibrous ankylosis, which may be intra- or extra-articular, or both combined, although osseous ankylosis may occur In another type of case, limitation of movement may be partly due to osteophytic developments. Deformity due to ankylosis in a bad position may be remedied by—

(*a*) Open or subcutaneous division of contracted bands, or other surgical procedures, such as excisions, osteotomies, etc

(*b*) Manipulation.

(*c*) Combination of (*a*) and (*b*)

(*d*) Gradual extension by means of apparatus.

Illustrative Case.

This illustrates the results of team-work in the treatment of what until recent times would have been considered a hopeless case. It also illustrates the extremely difficult and lengthy task which is so often the lot of the orthopædic surgeon when multiple deformities have un-

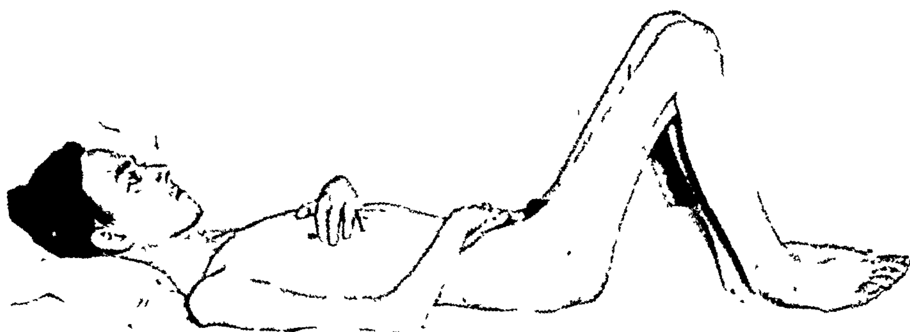


FIG 30—CASE OF F T B NOVEMBER, 1944

Helpless, bedridden, ankylosis of nearly all joints in severe deformity Weight 6½ stones Down but not out, and inspired with indomitable courage

necessarily developed by lack of precaution in the earlier and more acute stages

F. T. B., male, age 27, was admitted to the Rheumatic Unit, St. Stephen's Hospital, in November, 1944, suffering from a rheumatoid type of arthritis with multiple gross deformities The patient suffered



FIG 31—SAME PATIENT IN JULY, 1946, AFTER MEDICAL AND ORTHOPÆDIC TREATMENT

Marked improvement in all affected joints Weight 10 stones Is beginning to walk and goes to football matches

from exophthalmic goitre with thyrotoxicosis in 1940 He was treated at first as an out-patient at a London teaching hospital, and in October, 1943, thyroidectomy was performed. Three weeks after the operation he was sent to a convalescent home where he developed an acute polyarthritis of the rheumatoid type and was transferred to a general

weight suspended by a pulley (*e*) on the horizontal limb of the Balkan beam to control external rotation

In many cases adhesive plaster may be used instead of nail transfixion, and the same principles may be applied in cases of subluxation not amounting, as in the case described above, to complete dislocation. Similar treatment, with modifications suitable to individual cases, may be employed to correct deformity of the knee in arthritis when mainly due to muscular spasm.

In cases of slight or moderate degree of stiffness, manipulation is a measure of great value, it must, however, be performed carefully and gently, with proper attention to technique, and with personal attention to every detail of after-treatment.

One frequently hears of the dangers of manipulation, and particularly of the increased pain and shock that are said to follow this measure. Increase of pain and shock can occur only when either the patient's general condition or the degree of stiffness of the joint contra-indicate manipulation, when excessive force has been employed, or when the method was faulty, as when too much was attempted at one time

In performing a manipulation upon a joint stiffened by arthritic changes, it is important to bear in mind certain principles

1. Wait for a quiescent period If obvious signs of acute inflammation are present in the joint or joints, or if the sedimentation rate remains high, manipulation should be deferred until the acute symptoms have subsided.

2. Manipulation should not be performed unless the general condition of the patient is good, and should be avoided in the old and feeble.

3. Where stiffness is marked, an endeavour should be made to restore movement in stages, rather than run the risk of fracture of the atrophic bones and of exciting shock and reaction by trying to restore full movement at one time

4 In slight cases no retentive apparatus is necessary. In the more marked, it is wise to fix the limb temporarily in a splint or in plaster in the improved position. At the end of twenty-four hours, the splint may be removed or the plaster bivalved and gentle movements started. The retentive apparatus can be removed for any special treatment that may be deemed necessary, including muscular re-education, and reapplied at the end of each session.

5. A psychical element is frequently present. Firm, kindly, and tactful handling, and the gift of inspiring confidence and keen co-operation in the patient, are assets of the greatest value, indeed they are a *sine qua non* in the approach to such patients.

solution of sodium hypochlorite (Milton), that this procedure is often followed by lowering of the sedimentation rate and general and local improvement. This is not surprising, as such knee-joints are often veritable cesspools and may contain an ounce or more of slimy, necrotic debris. If, in addition, hypertrophied synovial fringes are present, the incision may be enlarged and the fringes removed with curved scissors. In marked cases a partial or complete synovectomy may be performed. There is evidence that these procedures may cut short the disease and probably prevent serious changes. An X-ray should always be taken to ascertain the exact condition of affairs and whether osseous loose bodies are present.

Next we come to a common type of case not associated with effusion. Irregular osteophytes develop around the articular margins, and destructive changes occur in the more central parts of the articular surface. Such changes are typical in the later stages of both rheumatoid and osteo-arthritis. In many of these, the limitation of movement is due both to mechanical obstruction by osteophytes and to peri-articular scarring.

What is the cause of the pain in these cases? Rational surgical treatment must be based upon the reply to this question. It is due to one or more of four main factors, certain of which may be combined, and all of which may be associated with muscular spasm:

1. Stretching of capsular scar-tissue, or of intra- or extra-articular adhesions.
2. Pressure by osteophytes.
3. Apposition of articular surfaces when covered with sensitive connective tissue.
4. Pressure upon enlarged and tender synovial fringes.

The pain in osteo-arthritis is in most cases due to the first and second of these, while many of the heroic operations sometimes recommended are based upon the assumption that the third factor is responsible

If we are faced with the first condition, a trial should be made of manipulation under anæsthesia, and occasionally surgical division of the contracted portion of the capsule may be indicated, as in division of the posterior portion of the capsule of the knee-joint. In the second condition, occasional benefit may follow operative removal of offending osteophytes.

In the third condition, it is important to remember that in true osteo-arthritis the articular surfaces tend to become eburnated—Nature's way of producing a new articular surface (Fig. 32). The

hospital. Here he had a course of gold therapy without benefit and all his joints were allowed to assume positions of gross deformity. He was then transferred to a spa hospital, where he had a further course of gold without improvement. In November, 1944, he was admitted to the Rheumatic Unit, St Stephen's Hospital He was extremely emaciated, his weight being 6½ stones, and the deformities shown in Fig 30 made him completely helpless On February 6, 1946, the B.S R being normal, an attempt was made to improve the knees and ankles by careful manipulation under anæsthesia Extension of both knees and ankles was slightly improved and plasters applied in the improved position After this a series of manipulations was performed upon all the stiffened joints upon March 6, April 3, and May 1 On May 14, 1946, a patello-trochlear arthroplasty was performed upon the right knee to correct the osseous ankylosis between the patella and the trochlear surface of the femur, the raw surface of the patella being clothed with allantoic membrane The movements of the right knee and particularly extension were further improved by this operation.

Further manipulations, followed in the case of the joints of the lower extremity by plasters, which were bivalved early for re-educational exercises, were carried out on June 26, July 24, August 14 and 28, 1946

The present condition of the patient is shown in Fig 31 His weight on September 9 was 10 stones (compared with 6½ stones on admission). Further orthopædic treatment will be required, as full extension of the knees is not yet possible and further improvement of other joints is hoped for. However, the improvement since his admission has been most gratifying He is now beginning to walk and goes to football matches This case is a good illustration of what can be accomplished when at first things look hopeless, and shows the immense amount of work that those who fail to take even the most elementary measures to prevent deformities bequeath to the orthopædic surgeon

Other Surgical Measures.—There is a large and important group of arthritic cases in which limitation of movement and deformity do not constitute the main features, but in which pain, in some cases associated with marked effusion, may be severe. Effusion is, of course, more frequently seen in the rheumatoid than in the osteo-arthritic type, whereas pain is often marked in both types

When a joint, particularly the knee, is the seat of pain and recurrent effusion, with an absence of or minimal osseous changes, a valuable surgical measure is to open the joint by one or more small incisions and to wash it out with an antiseptic solution and thus evacuate the large amount of necrotic and toxic material often present and for which ordinary aspiration is useless. The author has found in a series of cases of arthrotomy and lavage of the knee-joints with Dakin's solution, and more recently with an isotonic

a joint not infrequently throws abnormal strains and stresses upon adjacent joints, and may bring about arthritic changes therein. For instance, after ankylosis of the hip-joint, the patient may complain of pain and disability in the lumbar or sacro-iliac regions, and if arthritis supervenes in the other hip (as it frequently does) the patient's condition is pitiable indeed. In my personal experience, excision of the femoral head through a cruciate incision in the capsule is an excellent operation for the painful arthritic hip and infinitely preferable to arthrodesis.

The bifurcation osteotomy of Lorenz and McMurray's osteotomy are sometimes of value in relieving the painful arthritic hip in which manipulation is of no avail, and the painful disturbance of function associated with extreme adduction or flexion deformity of the hip may be appreciably improved by osteotomy.

Arthroplasty is sometimes of value in cases of bony ankylosis of certain joints, particularly in bilateral cases, but for a fuller description of the indications and technique of surgical operations in chronic arthritis reference should be made to the literature.

pain in these cases is therefore very rarely due to articular apposition *per se*. In the more chronic forms of rheumatoid arthritis, however, pain may be due to mutual apposition and friction of articular surfaces covered with sensitive connective tissue. In this group it is often necessary to decide whether the best policy is to aim at retaining a movable joint or to produce permanent ankylosis in the optimum position. A suitable plan of campaign is as follows.

In cases of arthritis in which pain is a prominent feature, and with only slight or moderate changes in the articular surfaces, a preliminary trial may be made of manipulation under anæsthesia. In the event of failure, an attempt should be made to prevent intra-articular friction by some form of "destressing" splint and limiting



FIG 32—POLISHED PORCELAIN-LIKE SURFACE OF INTERNAL FEMORAL CONDYLE IN ADVANCED OSTEO-ARTHRITIS OF KNEE-JOINT

the amount of exercise (in the lower extremity). Simultaneously the patient receives general and local treatment to the joint and its musculature to maintain nutrition and muscular tone. Particular attention should be paid to the important principle of carefully putting the joint through its full range of movement daily to prevent contractures, and to assist the natural cure by eburnation. If after a fair trial of such measures the pain is still marked, some form of surgical operation may be of great benefit provided that the patient's age and general condition do not contra-indicate this. As a general rule such surgical operations aim either at producing ankylosis or the retention of a reasonable degree of mobility.

It must be borne in mind that the production of ankylosis in

capsule and accessory ligaments which surround it. The cup-shaped acetabulum is deepened by the cotyloid and transverse ligaments.

The neck of the femur forms with the upper end of the shaft an angle of about 125 degrees (angle of inclination) in the vertical plane. This is subject to considerable variation in normal subjects. The angle of anteversion or anterior torsion is the angle which the neck makes with the transcondylar line. This also shows considerable variation in normal subjects and averages 15·3 degrees (Pearson).

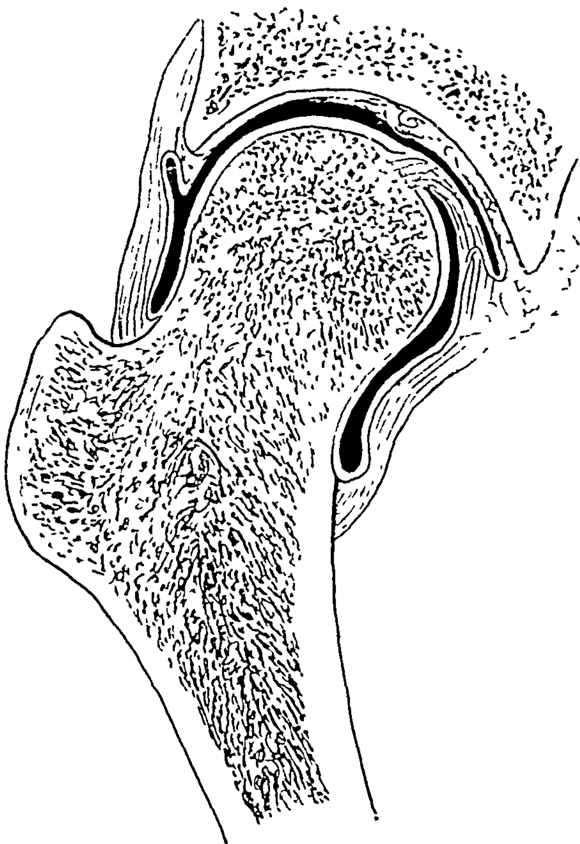


FIG 33.—CORONAL SECTION OF HIP-JOINT.

Shenton's Line.—In a radiograph of a normal hip the curve of the under aspect of the femoral neck is continuous with that of the upper and inner margins of the obturator foramen. This becomes altered in many injuries and diseases of the hip-joint.

Articular Capsule.—Is strong except in its postero-inferior part. Its proximal attachments are to the rim of the acetabulum above and behind, and to the cotyloid and transverse ligaments in front

CHAPTER VI

MANIPULATIVE TREATMENT: THE LOWER EXTREMITY

ALTHOUGH textbooks of anatomy usually describe the various movements that are possible at joints, it is rare to find adequate descriptions of such movements and of their normal range This is a serious omission, because it is obvious that **unless a practitioner has a clear idea of the normal range of a movement, it must be difficult or impossible for him to detect minor degrees of limitation. Moreover, if, in performing manipulation, a joint is forced beyond its normal range, a severe sprain or other damage may be done.** In this and following chapters, the indications for and the technique of manipulations will be preceded by brief descriptions of the surgical anatomy and of the normal movements possible at the joints. In this connection, mention must be made of the importance of **always comparing the movements of the joint, wherever applicable, with those of the opposite side.** For instance, many individuals normally have a few degrees of hyperextension of the knee-joint. On examining a knee-joint which has received an injury, one may easily conclude that extension is complete because the leg can be extended until leg and thigh are in the same straight line Examination of the opposite side may however reveal a slight amount of hyperextension to be normal for the individual. Limitation of full rotation of such joints as the shoulder and knee is also frequently overlooked, and yet a slight degree of limitation of such movement may constitute a marked disability. Limitation of many movements of the hip and shoulder is apt to be overlooked owing to compensatory movement of the pelvis in the former case and of the scapula in the latter. An inexperienced observer may fail to recognise that the hip-joint is ankylosed because on attempting to flex or abduct the thigh at the hip, the pelvis rotates and gives a false impression of movement at the hip itself. When testing hip-joint movement some means must therefore be taken for fixing the pelvis.

(A) *THE HIP-JOINT*

Surgical Anatomy (Fig. 33) —This joint is of the ball-and-socket type in which the head of the femur is received into the cup-shaped acetabulum. Unlike that other ball-and-socket joint, the shoulder, its strength depends to a large extent upon the shape and mutual apposition of the articular surfaces, and upon the strength of the

under the ilio-psoas by an opening between the ilio-femoral and pubo-capsular ligaments.

Normal Range of Movements (Figs. 34 and 35)—In testing the hip movements, the pelvis must always be fixed to prevent movement of the lumbar spine, which might create a false impression. The most reliable method of fixing the pelvis is to ask the patient to flex both hip and knee completely on the sound side and press with both hands his knee on to his abdomen. This prevents lumbar lordosis from obscuring fixed flexion of the diseased hip.

(*a*) Flexion can be carried out in the sagittal plane, and when the knee is simultaneously flexed, until the soft parts of thigh and

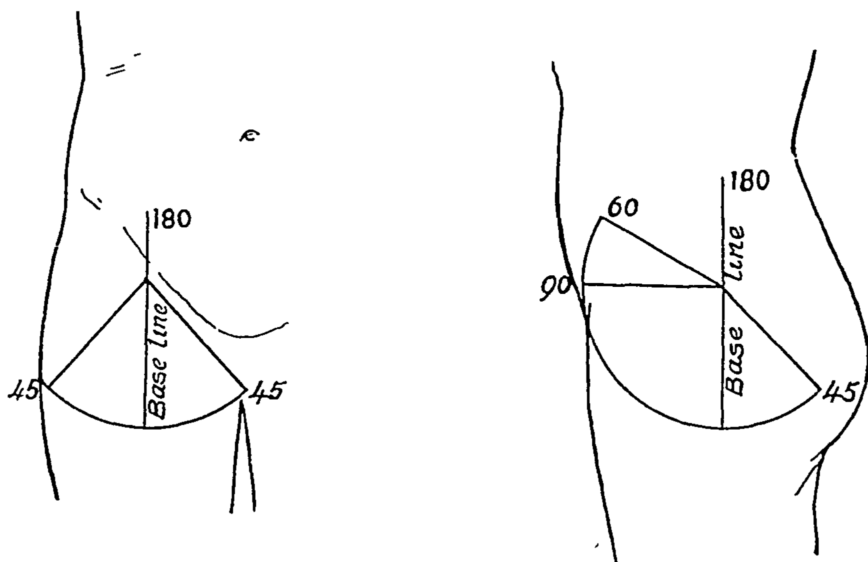


FIG 34—DIAGRAMMATIC REPRESENTATION OF RANGE OF HIP MOVEMENT

abdominal wall come into contact. It is, therefore, a variable factor. When the knee is extended, flexion of the hip is normally possible to an angle of 80-90 degrees, further movement being prevented by tension of the hamstring muscles.

(*b*) Extension is possible to an angle of about 45 degrees beyond the axis of the trunk, and is checked principally by the ilio-femoral ligament.

(*c*) Abduction exists to an angle of about 45 degrees, and is checked by the pubo-capsular and inner part of the ilio-femoral ligaments.

(*d*) Adduction is possible to an angle of 45 degrees.

(*e*) Circumduction is a combination of the above movements.

(*f*) External rotation exists through about 60 degrees, and is then checked by the outer part of the ilio-femoral ligament (Fig. 35).

and below Its distal attachments are anteriorly to the anterior intertrochanteric line, above and below to the root of the neck at its junction with the great trochanter and the femoral shaft respectively; and posteriorly to the femoral neck ½ inch above the posterior intertrochanteric line. The longitudinal fibres of the capsule are more marked anteriorly and above, while the circular fibres (zona orbicularis) are more prominent below and behind.

Accessory Ligaments—The Y-shaped ligament of Bigelow strengthens the front part of the capsule and is the strongest ligament in the body. It is narrow above where it is attached to the anterior inferior spine of the ilium, and broadens out below at its attachment to the anterior intertrochanteric line

Pubo-capsular Ligament—This stretches between the ascending pubic ramus and the lower part of the capsule

Ischio-capsular Ligament.—This stretches between the ischium just below the acetabulum, and blends with the circular fibres at the lower part of the capsule.

The *Retinacula* are capsular strands which are reflected upwards along the femoral neck from the root of the latter to its junction with the femoral head.

The *Ligamentum Teres* is a triangular ligament lying inside the joint and covered by synovial membrane. It is attached by its apex to a slight depression on the femoral head a little behind and below its centre, and by its base to the transverse ligament and margins of the acetabular notch. It is doubtful whether it plays any useful part, but it is rendered tense by flexion, adduction, and rotation outwards of the hip, as when one leg is crossed over the other in the sitting position.*

The *Synovial Membrane* lines the deep surface of the capsule, and covers the femoral neck as far as the margin of the head, so that the neck is contained in a tube of synovial membrane. The membrane also lines both surfaces of the cotyloid ligament, the surface of the Haversian pad of fat in the floor of the acetabulum, and is prolonged in the form of a sheath around the ligamentum teres. Occasionally, the synovial cavity of the joint communicates with the bursa

* Paley in his "Natural Theology" was greatly impressed by this structure and states "If I had been permitted to frame a proof of contrivance such as might satisfy the most distrustful inquirer, I know not whether I could have chosen an example of mechanism more unequivocal, or more free from objection than this ligament"

Morphologists, alas! consider it to be a vestigial and practically useless ligament. In all probability it belonged to the pectineus and has become separated from it by skeletal modifications.

ankylosis of the hip in good position that the effect upon function is much less than might have been expected, because in young persons, at any rate, there is increased and compensatory mobility of the lumbar spine.

Indications for Manipulation of the Hip-Joint.—Among the commonest causes of stiffness of the hip-joint amenable to manipulation are: adhesions following certain fractures in this region, ligamentous or muscular sprains and contusions which have led to limitation of some particular movement, chronic arthritis in which limitation of all movements of variable extent is usually present, and functional cases.

Manipulation of the hip is often of definite benefit in chronic rheumatic forms of arthritis, whether of the rheumatoid or osteo-arthritic types, and particularly in the more chronic forms associated with only a slight degree of lipping and a minimum amount of destruction of the articular surfaces.

The benefit often lasts a considerable time, and the manipulation can be repeated if necessary.

Sprains and contusions are far less frequent in the hip than in the knee-joint, owing to anatomical considerations. As we have seen, the strength of the hip-joint depends very largely upon the shape and accurate apposition of the femoral head and the acetabulum, and there is little likelihood of ligamentous injury except by a somewhat severe form of violence. Scar-tissue in the adjacent muscles is, however, of fairly frequent occurrence. For instance, injury to the adductor muscles (rider's strain) may lead to painful limitation of abduction, and limitation of extension may follow injury to the muscles in the groin.

Painful limitation of flexion of the thigh with simultaneous extension of the leg may follow a sprain of the hamstring group. In all of these types, stretching of the affected muscles under anæsthesia is often a valuable measure.

Manipulative Technique.—Manipulation of the hip should be performed upon a low couch, operating table or bed with a firm mattress. The pelvis of the patient should be fixed by an assistant, or by a firm pelvic band, as otherwise the desired movement does not take place at the hip-joint, but in the lumbar spine.

The general rule must be followed concerning the grips—viz., that when somewhat dense adhesions are present, a short leverage, and in cases of slight adhesions a longer leverage, is utilised. In the former (Fig. 36) the surgeon grasps the patient's thigh with both hands in the middle third and commences by gently rotating the joint. Throughout the manipulation traction should be exerted to en-

(*g*) Internal rotation, which is checked by the ischio-capsular ligament, exists through about 30 degrees (Fig. 35).

Owing to movement of the pelvis on the lumbar spine it is difficult to assess the true amount of abduction and adduction. A. R. Roscoe devised a special frame to fix the pelvis and tested these movements in a number of normal young men. He considers that the usual text book assessments are excessive, and that about 35 degrees of actual abduction and adduction are possible at the hip-joint itself.*

Prevention of Deformity (Figs. 20, 21 and 22).—In most diseases of the hip-joint the thigh assumes at first a position of abduction, flexion, and rotation outwards, which, from various observations clinical and experimental, appears to be the position of greatest ease. In the later stages, the thigh becomes adducted and rotated inwards, and flexion becomes more marked. The deformity tends to be obscured in most cases by pelvic and spinal movement. For instance, the abduction is masked by tilting downwards of the pelvis on the affected side, which causes the lower extremities to remain parallel to each other, with apparent lengthening of the lower extremity on the affected side, while the flexion is obscured by lordosis of the lumbar spine. Later, when the thigh becomes adducted, the pelvis is elevated on the affected side in order again to make the lower extremities parallel, and apparent shortening results. The tilting of the pelvis is associated with a compensatory scoliosis of the spine When actual destructive changes have occurred, real shortening is usually present. Often there is a combination of real and apparent shortening.

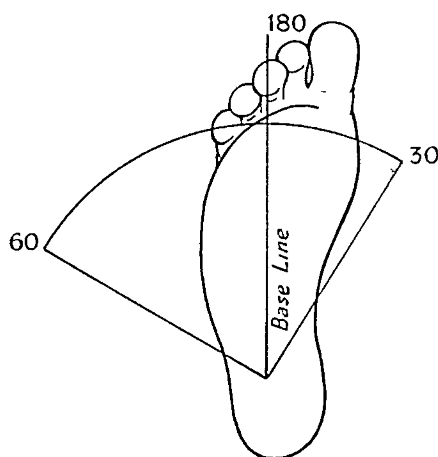


FIG 35 —ROTATION OF HIP

Unfortunately, the position that the diseased hip assumes is an unsatisfactory one from the point of view of functional use. Experience teaches that the best position for ankylosis of the hip is slight flexion through 10-25 degrees, very little if any abduction, and mid-rotation. It is quite common to find in many cases of

* A R. Roscoe, " The Range of Actual Abduction and Lateral Rotation at the Hip-Joint of Men," *Journal of Bone and Joint Surgery*, 1932, vol xiv, No 2, p. 325

movement of circumduction is of great importance, and should be performed after those of flexion, extension, abduction and adduction. As in manipulation of every joint, the normal range of movement must be carefully borne in mind, as if an attempt is made to exceed this movement, injury will be inflicted upon ligamentous, tendinous, or muscular fibres. In minor degrees of stiffness (Fig. 39) the surgeon grasps the lower end of the thigh in the region of the knee-joint with



FIG 37—MANIPULATION OF LEFT HIP. SHORT LEVERAGE (IN THIS CASE THE LEFT KNEE WAS ANKYLOSED AND IS RESTING ON THE OPERATOR'S LEFT SHOULDER)

one hand and, steadying the pelvis with the other, performs the manipulative movements in the order and manner described above. Fig 40 shows a useful method of applying traction to the hip-joint while performing manipulation, and may be used as an alternative to either of the methods described above

After-Treatment.—When a slight degree of limitation of movement was present before manipulation, and particularly in functional cases, re-education commences immediately. In more severe cases,

deavour to minimise friction between the femoral head and the acetabulum. The remaining movements are then carefully and slowly performed, taking care not to use undue force, and finishing with circumduction. The restoration of abduction is often difficult when secondary shortening of the adductor muscles is present. If, when the patient is fully under the influence of the anæsthetic, the tendon of the adductor longus can still be felt as a hard resistant structure, an attempt may first be made to remedy this by firm kneading and by rapid blows administered with the ulnar border of



FIG 36—MANIPULATION OF RIGHT HIP METHOD I SHORT LEVERAGE

the hand. *If this is ineffectual, it may be assumed that the* shortening is of the fixed type, and tenotomy of the adductor longus tendon may be performed with advantage. Where the contracture of the adductors is marked and fixed, open division, followed by manipulation, may be necessary. Similarly, in marked flexion deformity, open division of contracted structures is desirable. In performing extension, the patient should be placed in the lateral or prone positions (Fig. 38), and while an assistant fixes the pelvis, the operator, gripping the patient's leg just above the ankle, steadily extends the thigh while simultaneously applying traction. The

The practice of manipulation followed by complete fixation in a plaster spica for a considerable period is illogical and is not recommended if the object is to obtain an increased range of movement and retain a movable joint. A most important essential is to enlist the support of the patient's muscles in maintaining the increased range of movement. When completely fixed in plaster, the muscles waste with great rapidity, and the joint tends to stiffen in the new position. It is possible, however, to use plaster splintage in combination with early movements, and this method in the case of the



FIG. 39—MANIPULATION OF HIP. METHOD 2. LONG LEVERAGE.

hip involves the application of a double plaster spica which is divided within twenty-four hours in such a way that physical treatment and movements are permitted. At the end of each session the two halves of the plaster are reapplied.

When the patient has thus carried out a course of exercises under supervision, he is warned that the joint must be put through its full range of movement daily to prevent recontracture, particularly when manipulation has been performed for arthritis. To attain this end, the patient is instructed in certain exercises, and told that these are to be performed for a few minutes morning and evening. The

and particularly when abduction was previously restricted, the after-treatment adopted is as follows: The patient returns to bed, and the limb is fully abducted by means of sand-bags. To prevent tilting of the pelvis, the opposite limb should also be fully abducted. If pain is marked, an injection of omnopon gr. $\frac{1}{3}$ or heroin gr. $\frac{1}{6}$ is usually advisable. He lies thus for twenty-four hours, and receives massage for the whole limb. At the end of this period the



FIG 38 —EXTENSION OF LEFT HIP COMBINED WITH TRACTION (LONG LEVERAGE)

limb is carefully abducted and put through its full range of movement, at the end of which it is fully abducted again. At the end of a week it should be possible for the patient to move the limb without assistance through the increased range of movement. He is then allowed to get up and perform suitable exercises, at first assisted, followed later by those of a resisted nature. The movement of abduction is one to which particular attention should be paid.

restricted, particularly abduction. Wasting of glutei and thigh muscles on affected side X-ray revealed slight but definite osteo-arthritic changes, with lipping of the acetabular margin, but no evidence of gross absorption of articular cartilage. It was clear that the limitation of movement present was not due to osteophytic development, but to scar-tissue.

Under a general anæsthetic, manipulation was performed. Full movement was obtained with the employment of a moderate degree of force. The patient was returned to bed, and the affected limb maintained in the fully abducted position with sand-bags, and to prevent tilting of the pelvis the opposite limb was similarly placed. The following day the limb was massaged, carefully put through its full range of movement, and at the end of the session again fully abducted. This procedure was continued for a week. At the end of this time, the patient was allowed to get up, and commenced more strenuous exercise. It was now found that voluntary movements through complete range were perfect and painless, and they have thus remained, and the patient has been able to play tennis and other games without discomfort.

The *rationale* underlying the treatment in this case may be shortly summarised as follows:

It is probable that, owing to some transient infective or toxic condition, a degeneration of the central area of the articular surfaces occurred. This was followed by compensatory lipping and scarring of the joint capsule. The infective condition disappeared, but symptoms persisted, owing to the presence of the scar-tissue. The slight limitation of movement also prevented the natural cure of the joint condition by eburnation and sclerosis, and a vicious circle resulted. This was broken by manipulation, and subsequent contracture prevented by careful and painstaking after-treatment. The prognosis in such a case is good, provided regular movement through complete range is continued.

CASE II —Male, aged 43. Slight osteo-arthritis of hip, with large functional element Hip-joint had been immobilised by splints and plaster for five years All active movements of hip markedly restricted, but on examination under anæsthetic actual limitation of movement proved to be slight, although somewhat deep anæsthesia was necessary to abolish muscular spasm entirely.

The hip-joint was manipulated and full movement obtained. The patient was kept in bed for twenty-four hours with the affected limb fully abducted, after which active exercises with re-education were immediately begun Five months later the patient returned to his work, walking without a limp and without the use of a stick. Full movement of the hip was present, and the improvement has been maintained

possibility of insidious restiffening of the hip being concealed by compensatory pelvic movement should be explained to the patient and the necessary instructions given how to prevent this. The wearing of a calliper splint is sometimes advised after manipulation



FIG 40 —MANIPULATION OF RIGHT HIP METHOD 3 ALTERNATIVE METHOD OF APPLYING TRACTION

of the hip, but this is of doubtful value, and in the more chronic forms of arthritis a certain amount of weight-bearing is actually desirable to bring about that sclerosis and eburnation of the articular surfaces which is the natural method of cure.

Illustrative Cases.

CASE I.—B , aged 42 Pain in left hip-joint for five years, with increasing weakness and stiffness The pain was more marked after exercise, and the stiffness more apparent during the early period of the day. No history of previous illness, and general condition otherwise good. No obvious focus of toxic absorption present

On Examination.—All movements of the left hip-joint slightly

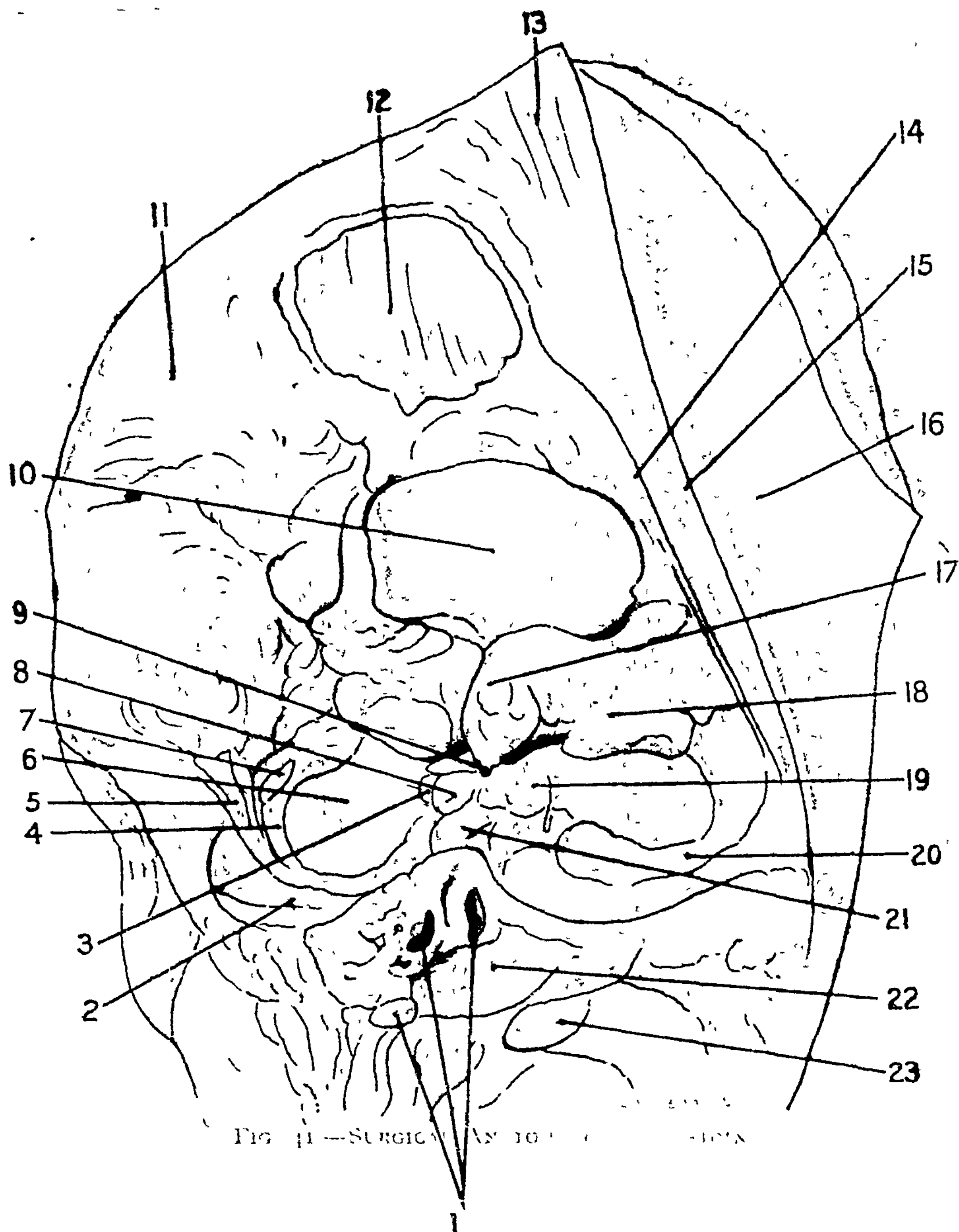


FIG 41 —SURGIC AN TO

1. Popliteal vessels and internal popliteal nerve
2. Outer head of gastrocnemius
3. External tubercle of tibial spine.
4. Synovial membrane at periphery of external semilunar.
5. Biceps tendon.
6. External semilunar cartilage in form of complete disc.
7. Popliteus tendon.
8. Anterior crucial ligament.
9. Ligamentum mucosum.
10. Patella.
12. Quadriceps tendon.
13. Subcrureus.
14. Synovial membrane
15. True joint capsule
16. Vastus internus.
17. Internal alar ligament or pad.
18. Internal semilunar pad
19. Internal tubercle of tibial spine.
20. Internal semilunar cartilage.
21. Posterior crucial ligament
22. Inner head of gastrocnemius.
23. Semimembranosus tendon

CASE III —Mrs T, aged 68 Complained of marked pain and stiffness of both hips, rendering walking impossible Both pain and stiffness had been present for several years, had been steadily increasing, and, after an attack of bronchitis during the previous winter, had rapidly become more marked.

The patient travelled up from the provinces upon a stretcher. X-ray examination revealed well-marked osteo-arthritis of both hips, with lipping of the femoral heads and acetabular margins All movements of both hips were markedly restricted, partly by osteophytes, and partly by muscular spasm Some flexion deformity of the left thigh was present

Treatment —After preliminary injection of scopolamine and morphine, gas and oxygen were administered, and manipulation of the hip-joints performed. A marked increase of range of movements resulted. Both thighs were abducted as fully as possible for twenty-four hours, during which time massage was given At the end of this period, active movements were instituted, and continued regularly

There was a marked improvement in the patient's condition when she left the nursing home ten days later. The increased range of movement had been maintained, and whereas she was carried *in* on a stretcher, she demonstrated her ability, before leaving, to walk well and to negotiate stairs Eighteen months later, a report stated " her walking powers are much increased, and she now goes about the house, up and down stairs, with the aid of only one stick " The improvement has since been maintained

(B) THE KNEE-JOINT.

Surgical Anatomy (Fig. 41).—No attempt will here be made to describe in detail such a complex subject as the surgical anatomy of the knee-joint. A short description of some special points may help to clarify many aspects of the treatment of knee-joint conditions amenable to manipulation.

Capsule and Ligaments of the Knee-Joint.

The capsule (or rather the aponeurotic capsule, as morphologically it is not the true capsule of the joint) is attached above and posteriorly to the intercondylar line and to the shaft of the femur immediately above the condyles.

Externally it is attached to the outer femoral condyle just above the groove for the popliteus tendon and internally to the internal femoral condyle below the adductor tubercle.

In front its place is largely taken by the quadriceps tendon, the patella, and the ligamentum patellæ. It receives reinforcements principally from the vasti, the ilio-tibial band, and the tendon of the

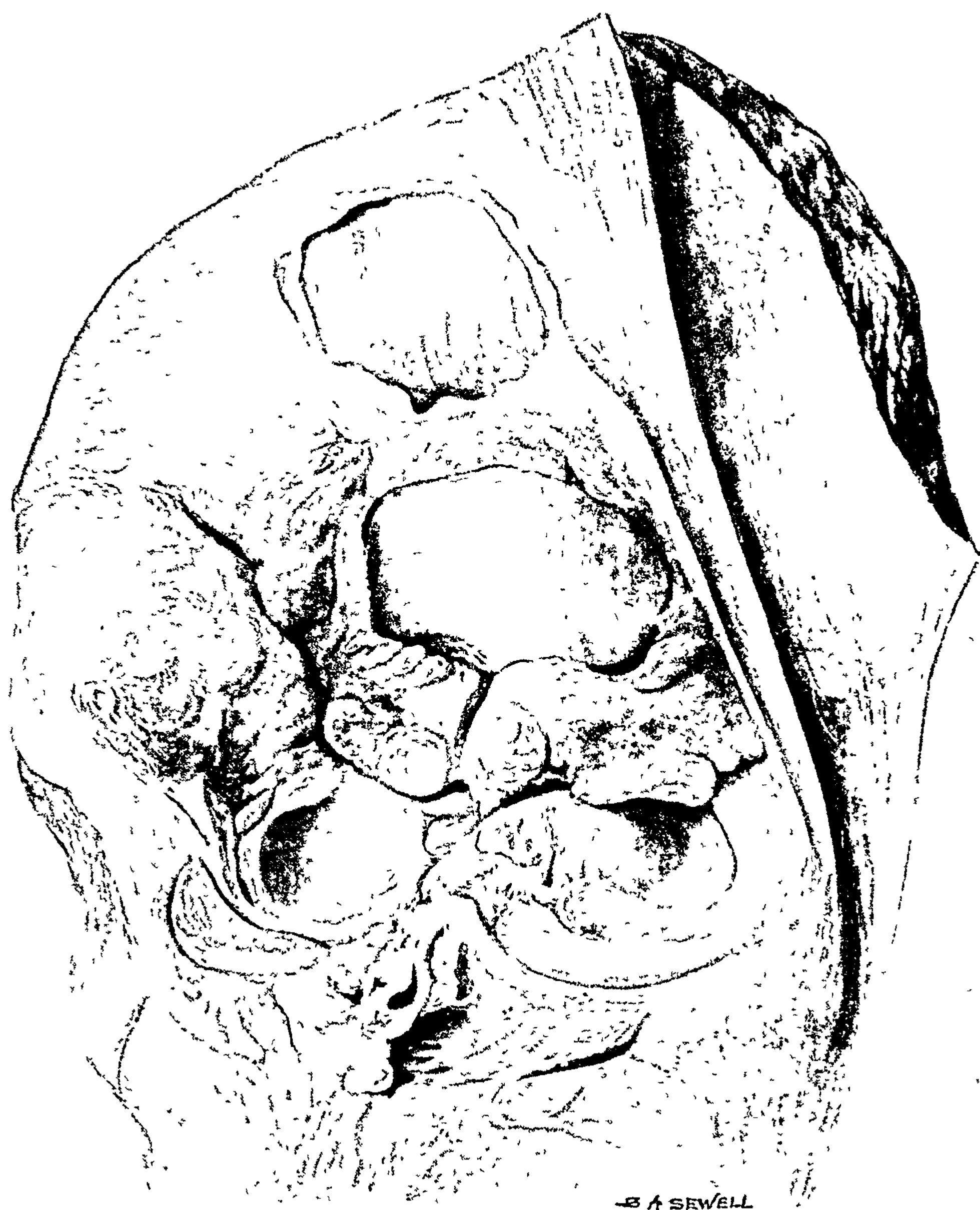


FIG 41.—SURGICAL ANATOMY OF KNEE-JOINT

The main function of the posterior crucial ligament is to prevent backwards displacement of the tibia in the same axis.

Both crucials probably assist in preventing excessive internal rotation of the femur upon the fixed tibia.

Semilunar Cartilages.*—A study of Figs. 41, 42 and 43, will give a better conception of their anatomy than any verbal description.

Briefly the semilunar cartilages are two crescentic plates of fibro-cartilage, wedge-shaped in section, which lie upon the peripheral part of the upper articular surface of the tibia.

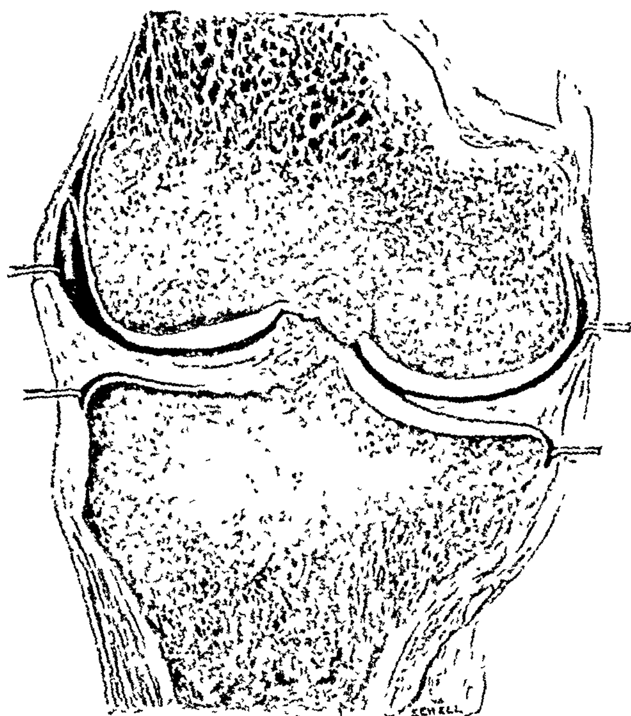


FIG 42 —CORONAL SECTION OF KNEE-JOINT, SHOWING SYNOVIAL RECESSES ABOVE AND BELOW SEMILUNAR CARTILAGES.

The Internal Semilunar.—The anterior horn is attached to the non-articular area of the middle of the upper surface of the tibia, in front of the anterior horn of the external semilunar and the anterior crucial ligament The posterior horn is attached to the same non-articular area immediately in front of the posterior crucial ligament.

The external semilunar is more circular in shape. Its anterior and posterior horns are attached to the non-articular area in front and

* See also A. G Timbrell Fisher, "Internal Derangements of the Knee-Joint Their Pathology and Treatment by Modern Methods," Second Edition (H K. Lewis & Co. Ltd)

semimembranosus. The latter reinforcement (the ligament of Winslow) is an oblique band which strengthens the posterior part of the capsule and runs upwards and outwards towards the back part of the external femoral condyle. The capsule is pierced behind by the tendon of the popliteus and is attached below to the head of the tibia $\frac{1}{4}$ to $\frac{1}{8}$ inch below its articular edge.

Ligaments of the Knee-Joint.—(*a*) *The patellar ligament*, which is the tendon of the quadriceps, is attached above to the apex and adjacent area of the patella and below to the tuberosity of the tibia.

(*b*) *The external lateral ligament* is a strong rounded cord attached above to the external femoral condyle just above the groove for the popliteus, which tendon runs beneath it and below to the head of the fibula, where it splits the biceps tendon. It is covered by the strong aponeurotic capsule, and at this level the arrangement of structures from within outwards is: (*a*) external semilunar; (*b*) tendon of popliteus, (*c*) cord-like external lateral ligament; (*d*) aponeurotic capsule.

(*c*) *The internal lateral ligament* is mainly in the form of a strong flat band about 4 inches long, which inclining slightly forwards as it descends, is attached above to the internal femoral condyle just below the adductor tubercle, and below to $1\frac{1}{2}$ inches of the inner surface of the tibia beginning 2 inches below the tibial margin. It sweeps over the tendon of the semimembranosus lying in its groove The posterior or short fibres of the internal lateral ligament are firmly attached to the peripheral surface of the internal semilunar cartilage just behind its centre, and to the upper border of the groove for the semimembranosus tendon, while other fibres sweep over the back part of the tendon and are attached to the lower margin of the groove.

The coronary ligaments are portions of the true morphological capsule stretching between the lower part of the convex margins of the semilunar cartilages and the edges of the tibial condyles.

(*d*) *The oblique ligament of Winslow* is a band from the semimembranosus tendon, which strengthens the capsule behind and runs upwards and outwards to blend with the capsule near the posterior surface of the external femoral condyle.

Crucial Ligaments.—These are a most important bond of union which lie in the centre of the joint in the gap between the femoral condyles and probably represent the lateral ligaments of two originally separate femoro-tibial articulations. The main function of the anterior crucial appears to be to prevent hyperextension and undue movement forwards of the tibia in the antero-posterior axis.

As a general rule, adhesions following synovitis occur in connection with that portion of the connective-tissue stratum nearest the joint cavity—viz., the so-called synovial membrane—whereas, in the case of a ligamentous sprain, the scar-issue may be present in the ligament itself, although often combined with true synovial adhesions from associated synovitis. Below and anteriorly, the synovial membrane is separated from the capsule and ligamentum patellæ by the infrapatellar pad of fat. Owing to the fact that the synovial stratum clothes the front and sides of the crucial ligaments, but leaves their posterior aspects uncovered, there is an area where the posterior crucial ligament is merely separated by loose areolar tissue from the back part of the capsule.

The synovial membrane extends upwards for a variable distance beneath the quadriceps extensor cruris, usually communicates with the suprapatellar bursa situated still more proximally, and clothes the intra-articular portion of the femoral diaphysis and epiphysis as far as the margin of the articular cartilage. It clothes both surfaces of the semilunar cartilages, although near the concave edge of the latter it cannot be identified as a definite layer, at any rate in adult life. Shallow synovial pockets are formed beneath the semilunar menisci (*vide* Figs. 42 and 43). It gives a sheath to the intracapsular portion of the popliteus tendon, and by means of this the cavity of the knee-joint may communicate with that of the superior tibio-fibular joint. It usually communicates with the bursa beneath the inner head of the gastrocnemius and the tendon of the semimembranosus. The ligamentum mucosum is a delicate fold of synovial membrane which passes upwards and backwards from the apex of the infrapatellar pad of fat to the front part of the intercondyloid notch of the femur. Its free margins are known as the ligamenta alaria. It represents what in some animals is a complete septum, dividing the anterior compartment of the joint into separate portions.* Posteriorly, and in relation to the back portions of the corresponding femoral condyles, are well-marked synovial recesses, which communicate on either side by a comparatively narrow channel with the large anterior compartment. The drainage of these posterior recesses in generalised suppurative arthritis often constitutes a difficult problem.

Movements (Fig 45).—*Flexion* is possible until thigh and leg come into contact, and is therefore, to a certain extent, a variable factor

* In the beaver, for example, the joint between the femur and tibia is divided into two separate parts by the crucial ligaments and by a septum of connective tissue There is also a separate synovial cavity for the joint between the patella and trochlear surface of the femur.

behind the tibial spine, and the two horns are embraced by those of the internal semilunar

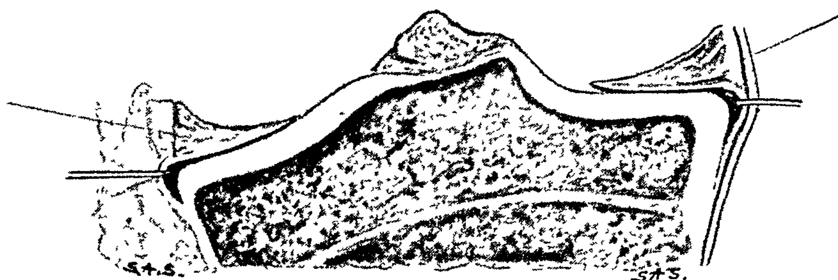


Fig 43 —Coronal Section of Head of Tibia, showing Semilunar Cartilages in situ.

The synovial pockets beneath the latter are clearly indicated

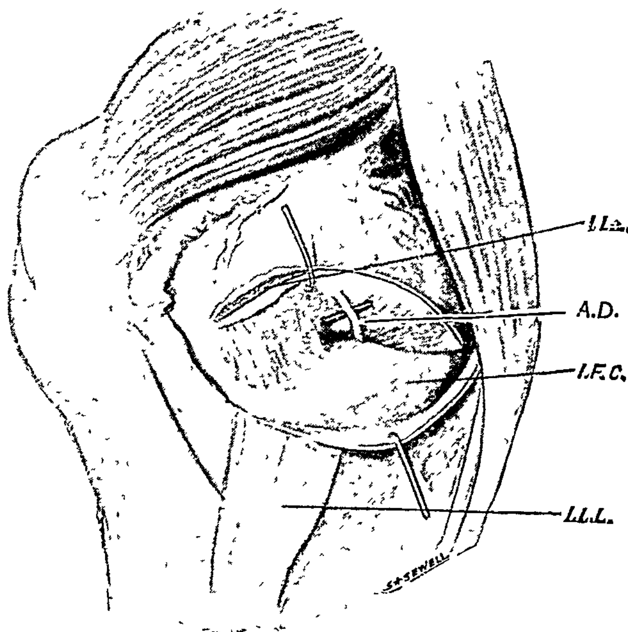


Fig. 44 —Synovial Recess beneath Internal Lateral Ligament of Knee-Joint, with an Adhesion (AD) in situ beneath which is a Small Glass Rod

I I L —Internal lateral ligament
I F C —Internal femoral condyle

Synovial Membrane.—This membrane clothes the inner surface of the capsule, and no sharp line of demarcation can be drawn between these two structures, except in the situations specified below.

passes from the fully flexed to the fully extended position and in complete extension is nil.

In flexion and extension, the condyles of the femur move upon the upper surface of the tibia and of the semilunar cartilages, and during this movement the femoral condyles not only roll, but glide, "like a cart-wheel hampered by a skid," according to Goodsir's classical description.* During rotation, movement not only occurs in this plane, but between the semilunar cartilages and the head of the tibia.

Indications for Manipulation of the Knee-Joint.

The examples which will be first given are of the after-effects of a common form of injury—viz., sprain of the internal lateral ligament of the knee-joint—although much will apply to other sprains of this joint. Afterwards, we shall discuss contusions, lesions of the semilunar cartilages, toxic or infective synovitis, chronic arthritis, combined cases, and functional cases.

Adhesions following Sprain of the Internal Lateral Ligament.

Before discussing the treatment of chronic cases of this injury, in which adhesions have formed, it is necessary to discuss the etiology and symptoms.

A complete rupture of the internal lateral ligament is a serious lesion which it is not proposed to discuss here. Sprain-fractures, in which avulsion of the upper bony attachment or occasionally of a portion of the tibia occurs, fall also into this category. Some, but by no means all, of these cases may be associated with a lesion of the internal semilunar cartilage or of the anterior crucial ligament.

There are, however, many cases in which a partial rupture or sprain of the ligament takes place, which may involve its upper attachment to the inner femoral condyle or the deep fibres near their attachment to the middle of the inner surface of the internal semilunar cartilage, or more rarely the lower tibial attachment. In minor cases, the tear may be so slight that a player is even for a time able to continue his game. It is in this large group that treatment is often inadequate, and the results unsatisfactory, owing to the production of a vicious circle.

Mode of Causation.—An injury to the deep fibres is usually produced when, the foot being firmly planted on the ground, the thigh is forcibly rotated inwards. Injury of the long or superficial portion is nearly always caused by forcible abduction at the knee. Some of

* "The Anatomical Memoirs of John Goodsir," edited by Wm. Turner, 1868

depending upon muscular development. It is brought about by the following principal muscles: biceps, semimembranosus, semitendinosus, gastrocnemius, popliteus, sartorius, and gracilis. At the commencement of flexion, there is an internal rotation of the tibia on the femur (or external rotation of the femur on the tibia), brought about by the popliteus, but afterwards the semitendinosus, semimembranosus, sartorius and gracilis assist in this rotatory movement.

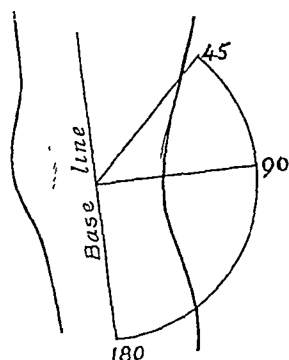


FIG 45 —RANGE OF KNEE MOVEMENTS

Extension is possible until the leg and thigh constitute one straight line, although many individuals possess the power of slight hyperextension of the knee. The movement is produced by the quadriceps extensor, and, at its termination, there is an external rotation of the tibia upon the femur—the so-called "screw-home" movement.

Internal rotation is checked by the anterior crucial ligament, and is produced by the popliteus and semitendinosus, and to a certain extent by the semimembranosus, gracilis, and sartorius

External rotation is checked by the internal lateral ligament, and is brought about by the biceps.

The amount of rotation at the normal knee is a somewhat variable factor, and depends upon the degree of flexion at the joint. In its assessment it is important to exclude movement at the hip and foot

The results of some hitherto unpublished tests by the author are as follows:

	External Rotation	*Internal Rotation*
Knee fully flexed	25-30 degrees	15-20 degrees
Knee flexed to right angle	15-20 degrees	10-15 degrees.
Knee midway between right-angled flexion and complete extension .. .	10-15 degrees	5-10 degrees.
Knee in complete extension . ..	nil	nil

It will be seen that external rotation is usually greater than internal rotation in every position, and the greatest amount of rotation usually occurs in full flexion in normal persons and not at right-angled flexion of the knee as is commonly stated. Occasionally the amount of rotation in full flexion may be approximately equal to, but rarely less than that in right-angled flexion. The amount of rotation steadily decreases as the knee

it was necessary to run a few yards and fall on the ball to score a certain try, but his limb refused to function and he was unable to move. This sudden muscular inhibition is probably reflex in nature

X-ray.—This should never be omitted and often shows an ossified or calcified periosteal flake after the first few weeks at the upper attachment of the internal lateral ligament.

Symptoms in Chronic (Neglected) Cases of Sprain.

Limitation of Movement.—It will usually be seen, especially if comparison is made with the opposite side, that full flexion of the knee is slightly restricted, and attempts to flex further are accompanied by pain on the inner side of the joint. Usually extension is also restricted, and here again it is necessary to distinguish this from the mechanical block to full extension present in an unreduced fracture-dislocation of a semilunar cartilage. A form of restriction of movement that is apt to be overlooked involves external or internal rotation when the knee is fully flexed. These limitations of movement are due to adhesions in and around the damaged ligament, and may be associated with synovial adhesions following recurrent attacks of synovitis.

Tenderness.—This is present at one or other of two typical sites. One is over the middle of the inner surface of the internal meniscus, while the second is over the inner femoral condyle just above the articular margin.

Recurrent Attacks of Pain and Synovial Effusion.—These are very characteristic symptoms. When the patient is taking things quietly the knee may be comparatively comfortable. Any increased exertion, however, is apt to cause a painful " flare-up."

Loss of Muscular Tone and Wasting.—This occurs rapidly, and particularly affects the quadriceps extensor (quadriceps " insufficiency "). The vastus internus element is always prominently affected. Normally this segment of the quadriceps extensor plays an important part, not so much in extension of the leg, but in steadying the inner side of the joint when weight is borne upon the partially flexed knee. It is particularly brought into play by balancing movements. This muscular weakness often gives rise to a sensation of " giving-way " of the knee. Its treatment and complete cure are often a very difficult and prolonged matter. Defective treatment of a knee sprain by a long period of immobility may lead to a degree of muscular wasting, which may take many months or even years to rectify completely. Sometimes the thigh

the most severe lesions of this portion of the ligament may be produced in sport, by another player falling against the outer side of the patient's thigh or leg while his foot is fixed firmly on the ground.

Symptoms.—In all instances, pain, which may be very acute, is experienced on the inner side of the joint. Sometimes the patient states that a definite "snap" occurred, and in some the history may suggest that true mechanical locking took place. However, on careful investigation of the history it will usually be found, in uncomplicated cases of ligamentous injury, that the inability fully to extend the knee-joint was due to pain and muscular spasm, rather than to true mechanical obstruction

Pain and tenderness are always present, their maximum intensity depending upon the exact position of the rupture At first, pain in the knee may be more or less generalised, but later more accurate localisation to the actual site of the lesion usually occurs.

In some forms, tenderness can also be elicited over the anterior end of the internal meniscus, and, in the more severe, the pain may be referred upwards into the thigh and downwards into the calf.

Swelling at the site of the lesion may be absent in minor sprains. In the more severe, a boggy swelling may soon be felt at the site of the rupture owing to the presence of hæmorrhagic effusion. This may be marked, and the subsequent bruising may extend for a considerable distance upwards into the thigh and downwards into the calf.

Synovial Effusion—As a general rule the greater the degree of injury to the ligament, the sooner does synovial effusion manifest itself. It may occur almost immediately if the effusion is largely hæmorrhagic. In sprains of average severity, the effusion does not manifest itself for several hours, and may even be first noticed upon the morning succeeding the injury.

Limitation of movement is almost invariably present from the first, and this earlier limitation is due to the fact that movement, being painful, causes reflex muscular spasm. This particularly applies to the movement of extension, which stretches the damaged ligament. A painful limitation of extension of the knee is thus present at first owing to protective spasm of the flexors. This needs to be carefully distinguished from the mechanical block to extension that occurs in some cases of injury to the semilunar cartilage and which is also often associated with considerable muscular spasm at the time of the original injury.

Loss of Power.—This is an important feature, and apt to manifest itself in various ways. For instance, during a rugby match, one of the team sprained his internal lateral ligament, but endeavoured to continue. At one moment he found himself in a position where

1. The increased range of movement obtained by manipulation must be preserved, and consolidated by the patient exercising the joint through the increased range at regular intervals, commencing immediately.

2. The wasted thigh muscles must be made to recover their tone and bulk by re-educational exercises. It will then often be noted that lateral mobility gradually disappears.

Pathology of Cure by Manipulation in Cases of Chronic Sprain.

The internal lateral ligament is stretched on full extension, but relaxed during flexion. It is difficult, therefore, to explain the actual mechanical limitation of flexion by the presence of scar-tissue solely in the ligament itself. To appreciate the conditions present, the anatomy of the region should be recalled.

Surgical Anatomy.—The relationship of the various parts may be seen by reference to the accompanying figures (Figs. 42 and 44).

It will be seen that beneath the upper part of the internal lateral ligament near its femoral attachment is a synovial pocket or recess, which forms part of the synovial reflection from the femoral condyle to the capsule.

Normally, the two layers of synovial membrane are in contact, and the internal lateral ligament is in contact with the outer synovial layer

In ruptures of the long portion of the internal lateral ligament, either partial or complete, it is clear that the synovial membrane must participate. If the joint is kept at rest, the two opposed layers of synovial membrane become glued together by inflammatory exudate, which may become organised into connective tissue with the formation of an adhesion. Furthermore, the outer layer of the synovial membrane becomes adherent by fibrous tissue to the scar in the ligament

There is no greater contributory factor in the formation of these adhesions than prolonged treatment by complete rest, associated with such compressing agents as plaster, Scott's dressing, and strapping. In fact, by a prolonged use of these methods the adhesion of the two opposed layers of synovial membrane is made almost certain

Another shallow synovial pocket is also present beneath the attached margin of the semilunar, where the synovial membrane lines the deep surface of the coronary ligament and is reflected from it to the margin of the tibial condyle (Figs. 42 and 43).

After rupture of the deep fibres of the internal lateral ligament,

muscles never recover their original bulk, although the tone may recover, and it may be possible for the patient to play strenuous games. It must be remembered that the glutei and tensor fasciæ femoris often participate in this loss of muscular tone and wasting.

Lateral Mobility is commonly present. In severe forms it may be elicited almost at once, but this test should be performed with care, to avoid further damage to the internal lateral ligament. In milder forms, lateral mobility occurs later, and is due to stretching of the articular capsule by recurrent effusions and to loss of the normal support of the capsule from weakness of the thigh muscles In testing for lateral mobility, the opposite side should always be examined, for in many individuals a slight degree of lateral mobility, or even of hyper-extension, is normal, and may cause no interference with function.

Treatment of Chronic Cases in which Adhesions have Formed.

The modern treatment of sprains of the knee in the earlier stages is discussed in Chapter III. In many chronic cases, we are faced with a set of conditions constituting a vicious circle. The sprain has given rise to synovitis, this brings about wasting of the thigh, and the resulting laxity of the capsule still further predisposes to minor traumata of the synovial membrane, synovitis, and delayed absorption of synovial fluid. It should be pointed out that the tenderness over the internal lateral ligament is due to the presence of scar-tissue, which may be present, not only in the ligament itself, but in the synovial membrane lining its deep surface, which, indeed, may be adherent to the scar. When stretched, this gives rise to a sensation of acute pain and a reaction in the joint; hence the recurrent attacks of pain and effusion that occur after exercise. The presence of scar-tissue in excess is the cause of this syndrome, and the great principle of treatment is to deal effectively with this, and subsequently to concentrate upon the treatment of the resulting conditions The latter are sufficient in themselves to give rise to serious trouble and a continuance of symptoms, when the internal lateral ligament itself has ceased to be a source of trouble *per se* When adhesions have actually developed which persist after a fair trial has been made of physical treatment, including re-educational exercises, the vicious circle may be broken by manipulation, the technique of which is described below.

In slight cases this measure is all that is necessary, but in the more marked, the after-treatment is important, and attention to the following main points is necessary:

that the fluid previously present had subsided (an interesting and common feature after manipulation), and the patient stated that the pain was greatly relieved. The movements were now full, although very slight tenderness was still present at the above-mentioned spot. This, however, disappeared after treatment by ionisation with potassium iodide. Progress was steady, and six days after the manipulation he played in a practice game and three days later played against one of the Universities

Defects in Original Treatment giving Rise to Clinical Syndrome.

The principal defect can be summed up quite shortly, for it consists in immobilisation for too long a period. Cases of complete rupture of a ligament probably come into a different category,* but there is no evidence that early movements in cases of sprain or partial rupture are productive of anything but good, provided they are limited to flexion and extension, and that rotation be avoided at first. The movement of flexion, as it relaxes the lateral ligaments, cannot interfere, if carefully performed, with the process of repair. The great value of these early movements is that they prevent the formation of adhesions between the opposed layers of synovial membrane and between the synovial membrane and the ligamentous scar.

Contusions of the Knee-Joint.

It is now well recognised, with the more general use of X-rays, that many cases of contusion are complicated by fracture into the joint, such as fracture of the patella or vertical fissured fracture of the head of the tibia. Small fragments of bone may more rarely be detached immediately from any of the three bones entering into the articulation and constitute loose bodies.†

A loose body may also be due to the gradual exfoliation of a portion of the articular surface by a localised osteo-arthritic process, or by the process that Konig designated osteo-chondritis dissecans. This type of loose body also frequently follows severe contusion of the joint, although the actual separation of the fragment of the articular surface may be delayed. The condition is usually followed by more generalised osteo-arthritic changes.

* In complete rupture, temporary immobilisation by means of an ambulatory plaster is desirable, and adhesion formation is largely prevented by allowing free movement of the proximal and distal joints, as in the Bohler method of treating many fractures In any case, adhesions, especially if of slight or moderate degree, are a lesser evil than the marked instability resulting from an unhealed rupture of the lateral ligament

† A G. Timbrell Fisher, "A Study of Loose Bodies composed of Cartilage or of Cartilage and Bone occurring in Joints," Hunterian lecture, *Brit. Journ of Surgery*, 1920-21, vol. viii, pp 493-523.

adhesions are particularly liable to form at this site, giving rise to persistent tenderness and recurrent attacks of pain, synovial effusion, and even minor attacks of locking.

The tenderness at this site is often wrongly considered to be due to a lesion of the semilunar cartilage, and when a cure results from manipulation in this type of case, the bone-setter may unjustifiably claim that by manipulation it is possible to cure chronic lesions of the semilunar cartilages.

In addition to the adhesions that occur in the region of the damaged ligament, generalised synovitis, if present, may cause the development of adhesions inside the joint cavity and particularly in the region of the infrapatellar pad of fat (Fig. 6).

CASE —In this case the long or superficial fibres of the internal lateral ligament were damaged near their upper attachment.

The captain of an international rugby team had been unable to play for some three weeks owing to an injury to his right knee He stated that another player fell against the outer side of the knee, and he immediately felt severe pain on the inner side of the joint, but endeavoured to continue the game, although the knee felt weak, painful, and unreliable There was no " locking " of the joint. At one moment during the game it was only necessary for him to run a yard, and fall on the ball to score a certain try, yet he found that, owing to sudden loss of power in the limb, he was unable to move. After the game he noticed that the knee was swollen He went to a theatre in the evening, and after sitting in a somewhat cramped position and attempting to rise he experienced sudden acute pain on the inner side of the joint.

He spent the next day in bed, the limb was massaged, and the effusion soon subsided, but the limb remained weak and powerless, and any exercise such as running caused sudden painful giving-way of the knee It was feared that his injury would keep him out of the team for the remainder of the tour

On examination it was seen that very slight synovial effusion was present, but there was no tenderness over the internal semilunar cartilage or elsewhere, except at one very definitely localised area near the upper attachment of the internal lateral ligament Full flexion of the knee was restricted and painful There was slight loss of tone of the quadriceps extensor affecting principally the vastus internus.

The following day manipulation was performed, the joint being put through its full range of movements by a series of short and rapid movements, particular attention being paid to the attainment of full flexion An adhesion was heard to give way during the latter movement.

A compression bandage was worn for twenty-four hours, and the patient advised to take things quietly for this period

Re-educational exercises commenced the next day, when it was noted

the knee, but afterwards the joint swelled considerably. The doctor whom he consulted considered that the semilunar cartilage had been torn and put the limb into a plaster-of-paris splint. The swelling of the joint gradually subsided, but the thigh and calf muscles wasted rapidly, the limb felt generally weak and unreliable, and there was also a distinct feeling of pain under the patella when any strain was put on the knee.

On Examination—Slight generalised synovial effusion present. Tenderness over infrapatellar pad of fat on firm pressure No tenderness over either semilunar cartilage or over the lateral ligaments.

Wasting and loss of tone of the right quadriceps extensor, principally involving vastus internus.

Movements—Flexion and extension full, but movements of patella laterally somewhat restricted. Definite lateral mobility present. X-ray revealed no abnormality.

Manipulation was performed under nitrous oxide anæsthesia, and the lateral movements of the patella completely restored. After twenty-four hours' rest, no effort was spared either by the patient himself or the masseur to restore the wasted quadriceps. There was no recurrence of effusion, and ere long he was able to play football without ill-effects.

It seems clear that in this case the original injury was a contusion which gave rise to synovitis, that adhesions in the region of the infrapatellar pad of fat resulted, and that gradually the symptoms to which the latter gave rise overshadowed those due to the original injury

CASE II—An example of a somewhat similar condition to that described above, but eight years had elapsed since the original injury, and, as so often happens in chronic cases, a functional element had become superadded

Manipulation is of particular value in this type of case, but it is obvious that the after-treatment must of necessity be somewhat more prolonged than in the less complicated type of case described above.

A young woman was involved in a taxi-cab accident eight years previously, in which she sustained a severe contusion of her right knee

Much pain and effusion followed, for which a considerable period of rest with strapping was prescribed When the strapping was at length removed, the knee was very stiff and the quadriceps wasted This state of affairs was remedied to a certain extent by a long course of massage and re-education, but any exercise brought on effusion and pain in the lower and front part of the joint

The symptoms were so similar to those described above that they will not be described separately

The functional element was shown by complaints of scarlet patches over the affected knee during the painful spells. These were seen by her medical adviser, although the joint otherwise appeared quite free from acute signs.

The treatment consisted in manipulation, when, during rotation, a definite "snap" was heard An equally important result was the powerful suggestion of this mode of treatment and its effect upon the

A contusion is thus often the precursor of more generalised osteo-arthritic changes. Myositis ossificans must always be considered as a possible cause of prolonged disability after contusion, and in a doubtful case an X-ray should always be taken. Often a certain amount of hæmorrhagic effusion occurs and mingles with the synovial effusion. In the severest forms of contusion blood predominates, constituting a hæmarthros.

Loose bodies formed of blood-clot may follow this condition, or the hæmorrhage may occur into a synovial fringe and form a pedunculated loose body

The infrapatellar pad of fat may undergo slow inflammatory enlargement as the result of a contusion, and give rise to pain on full extension or a slight limitation of this movement. A discussion of these interesting conditions is beyond the purpose and scope of this section. Adhesions, however, are not infrequently a sequel of a severe joint contusion.

Contusions, like sprains, are very liable to be followed by synovitis with effusion, and much that has already been said concerning the general pathology of adhesions in cases of sprain applies also to adhesions following contusion There is, however, a tendency in the latter for adhesions to be more generalised, and although they may occur almost anywhere, they tend to be more marked in the front and lower part of the joint, in the region of the infrapatellar pad of fat and its processes, and at the lateral synovial reflections. The adhesions may be of great delicacy, and may be localised or diffuse.

Localised tenderness is often present at the site of the original contusion, with limitation of some particular movement or movements. In this connection, the movements of the patella laterally and the rotatory and "screw-home" movements of the tibia should always be tested.

The pathology of this type of case is described more fully by the author elsewhere.*

In the case to be first described, nearly a year had elapsed since the original injury, which was a contusion. The striking facts about the clinical picture were the recurrent attacks of pain and effusion after intervals of comparative freedom, and the absence of tenderness either over the semilunar cartilages or lateral ligaments.

Case I —An undergraduate association football player stated that eleven months previously, while kicking the ball, the opposing goal-keeper's shoulder struck his right knee, and there was a general feeling of everything being twisted from right to left. There was no locking of

* "Internal Derangements of the Knee-Joint. Their Pathology and Treatment by Modern Methods," Second Edition (H K Lewis and Co, Ltd.)

and gentle movements were begun and a little weight-bearing permitted. This, however, caused increase of pain and recurrence of swelling. Tuberculous disease was suspected, although the patient's general condition was excellent and the family history was negative.

On Examination.—A healthy-looking boy walking with the aid of crutches and keeping the affected knee rigidly extended. There was no swelling of the knee and no raised temperature over the joint. There was considerable limitation of movement, but owing to the marked degree of muscular spasm it was not possible to state definitely how much of the limitation was due to spasm and how much to adhesions. Tenderness was elicited over the internal lateral ligament in the joint interval, and marked wasting of the thigh was present. X-ray revealed no abnormality. Careful consideration of the history and of the signs and symptoms, particularly the absence of heat over the joint, the negative X-ray, and the patient's excellent general condition, did not support a diagnosis of tuberculous disease; the condition was considered to be one of adhesions following the series of attacks of traumatic synovitis. Manipulation was accordingly performed. When muscular spasm was abolished by anæsthesia, it was found that the last twenty degrees of flexion were definitely prevented by adhesions. These adhesions were carefully broken down, full flexion was obtained, and the usual after-treatment followed. Three weeks later it was almost impossible to detect any abnormality in the joint. Movement was full, there was no swelling, he was able to walk without a limp, and the musculature of the thigh had already greatly improved. Permission was given to cycle, and the improvement was steadily maintained.

Manipulation in Original Lesions of the Semilunar Cartilages associated with Mechanical Locking.

"Locking" often, but by no means always, occurs at the time of the original injury to the semilunar cartilage; and when it exists it nearly always takes the form of a mechanical block to full extension of the joint by some 10 or 20 degrees.

Every case of original injury to a semilunar cartilage should be treated as follows.

(*a*) Replacement by manipulation of the fractured and displaced fragment of the semilunar cartilage, thus removing the mechanical block to full extension of the knee.*

* It should be noted that, in the opinion of many surgeons, removal of the offending semilunar cartilage is the correct treatment for the original fracture-dislocation Manipulative replacement, it is rightly claimed, is no guarantee against subsequent displacement. On the other hand, manipulative replacement of the original lesion *may* be permanently curative, and removal of the semilunar cartilage may, in a small minority of cases, be followed by troublesome sequelæ. The time factor often causes the patient and surgeon to decide upon early removal, and each case must be decided upon its own merits

functional condition and the breaking-down of a vicious circle. A course of special re-educational exercises followed immediately, under which the wasted muscles largely recovered their bulk and tone, and the end result was satisfactory.

The Simulation of Tuberculous Disease of the Knee-Joint by Traumatic Articular Adhesions.

In some instances, articular adhesions following trauma may simulate tuberculous disease somewhat closely. Owing to this fact, many cases for which massage and mobilisation are the correct treatment are treated by immobilisation until troublesome or even irremediable stiffness has occurred. The principal diagnostic features of tuberculous arthritis are enumerated elsewhere Great difficulty confronts us in deciding whether to prescribe absolute rest or mobilisation in many cases where diagnosis remains doubtful

In such doubtful cases it is justifiable to try the effect of very carefully administered radiant heat, and gentle assisted movements, while simultaneously reducing weight-bearing to an absolute minimum.

If this treatment actually relieves pain and disability and brings about improved and comparatively painless movement, although at first through a restricted range, it is highly improbable that we have to deal with a case of tuberculous disease. One may, if the treatment continues to give rise to improvement, supplement it and expedite recovery by a series of manipulations when considered advisable.

If, on the other hand, the treatment, although carefully given, causes an increase of pain, spasm, and other symptoms, the possibility of tuberculous disease must be seriously considered.

The following case illustrates many of these points:

B , aged 15, complained of pain and stiffness of the left knee. Three or four years previously he fell from a fence and sprained the knee, and shortly afterwards injured the joint in a bicycling accident; considerable synovial effusion followed, which subsided after complete rest and splintage Subsequent use of the limb caused slight synovial effusion without much pain, but flexion of the knee remained slightly impaired. A series of slight injuries to the joint followed, each being accompanied by synovial effusion and increased stiffness. The last of these injuries was a contusion received five months before reporting. This was followed by somewhat persistent synovial effusion, pain, and limp A doctor was consulted, who ordered the patient to bed The swelling subsided in a fortnight, and after being supplied with a poroplastic splint to keep the limb fully extended, the patient was allowed to get about with crutches. This splint was worn for about four months, and then massage

and gentle movements were begun and a little weight-bearing permitted This, however, caused increase of pain and recurrence of swelling. Tuberculous disease was suspected, although the patient's general condition was excellent and the family history was negative.

On Examination.—A healthy-looking boy walking with the aid of crutches and keeping the affected knee rigidly extended. There was no swelling of the knee and no raised temperature over the joint. There was considerable limitation of movement, but owing to the marked degree of muscular spasm it was not possible to state definitely how much of the limitation was due to spasm and how much to adhesions. Tenderness was elicited over the internal lateral ligament in the joint interval, and marked wasting of the thigh was present. X-ray revealed no abnormality. Careful consideration of the history and of the signs and symptoms, particularly the absence of heat over the joint, the negative X-ray, and the patient's excellent general condition, did not support a diagnosis of tuberculous disease, the condition was considered to be one of adhesions following the series of attacks of traumatic synovitis Manipulation was accordingly performed. When muscular spasm was abolished by anæsthesia, it was found that the last twenty degrees of flexion were definitely prevented by adhesions. These adhesions were carefully broken down, full flexion was obtained, and the usual after-treatment followed Three weeks later it was almost impossible to detect any abnormality in the joint. Movement was full, there was no swelling, he was able to walk without a limp, and the musculature of the thigh had already greatly improved. Permission was given to cycle, and the improvement was steadily maintained.

Manipulation in Original Lesions of the Semilunar Cartilages associated with Mechanical Locking.

"Locking" often, but by no means always, occurs at the time of the original injury to the semilunar cartilage; and when it exists it nearly always takes the form of a mechanical block to full extension of the joint by some 10 or 20 degrees.

Every case of original injury to a semilunar cartilage should be treated as follows.

(*a*) Replacement by manipulation of the fractured and displaced fragment of the semilunar cartilage, thus removing the mechanical block to full extension of the knee.*

* It should be noted that, in the opinion of many surgeons, removal of the offending semilunar cartilage is the correct treatment for the original fracture-dislocation Manipulative replacement, it is rightly claimed, is no guarantee against subsequent displacement On the other hand, manipulative replacement of the original lesion *may* be permanently curative, and removal of the semilunar cartilage may, in a small minority of cases, be followed by troublesome sequelæ. The time factor often causes the patient and surgeon to decide upon early removal, and each case must be decided upon its own merits

(*b*) Temporary rest from weight-bearing until the more acute symptoms have subsided, combined with the wearing of a compression bandage applied over a thick layer of wool completely surrounding the joint. Physical treatment in the form of massage and active movements is prescribed to assist absorption of synovial effusion and to prevent muscular wasting and the formation of adhesions. Such early movements after reduction, provided rotation is avoided, are more likely to bring about repair of peripheral tears of the semilunar cartilage than the long period of immobilisation that is often ordered and which is apt to cause adhesion formation and muscular wasting

(*c*) The avoidance for several weeks of strain upon the newly formed fibrous tissue at the site of the lesion in cartilage and ligament.

Diagnosis and Treatment of Chronic Lesions of the Semilunar Cartilages.

The author has experimentally investigated the problem of repair in the semilunar cartilages, and has also examined microscopic sections of fractured semilunar cartilages removed at operation at various intervals from the original injury. These investigations all point to the fact that repair in the menisci is extremely sluggish and probably only occurs in tears of the extreme peripheral zone, which is covered by a thin extension from the synovial membrane containing bloodvessels.

This fact explains why the original fracture of the semilunar cartilage is so frequently followed by recurrence of symptoms and particularly by attacks of mechanical locking.

The most characteristic feature of a recurrent lesion of a semilunar cartilage is the history of one or more attacks of true mechanical locking, which may be momentary or last until reduced by manipulation, when reduction often occurs with an audible "snap" In some cases, where mechanical locking occurs at the original accident, the recurrent symptoms take the form of sudden giving-way, associated with a loud report, crack, or snap, rather than true locking. On the other hand, locking may not occur at first, but on subsequent occasions A patient in whose knee-joint the author found tears of both semilunars stated that any sudden turning movement was associated with a report "like a double-barrelled gun."

At first the recurrent attacks are associated with considerable pain and synovial effusion, although as a rule the symptoms are not quite so acute as at the time of the original injury.

In time the reaction following each attack of locking may become

slight, although the attacks may become more frequent. It is not uncommon to encounter cases in which attacks of locking occur several times a day, and the patient has learned to unlock the joint himself by some particular movement.

A helpful feature in differential diagnosis is the clear and often detailed history that an intelligent patient may give. The exact position of the limb which produces the "locking" may be demonstrated.

It is justifiable to explore the knee-joint when such a detailed history characteristic of a semilunar cartilage is given by a reliable patient, even when physical signs are absent or negligible, as they may be between attacks.

True mechanical locking must be carefully distinguished from limitation of movement due to synovial effusion and pain, and from other forms of mechanical locking, as may occur with loose body or certain injuries to the tibial spine.

Sometimes the symptoms of recurrent semilunar derangement are less typical. For instance, it is obvious that if merely a minor type of lesion is present, this will not bring about true locking, and the symptoms will approximate more to those of chronic sprain of the corresponding lateral ligament, and there may be a complaint of "giving way" of the knee rather than of true locking. It is sometimes impossible to diagnose this type from sprain, and it should be treated as the latter at first. Suspicions should be aroused if the symptoms of the alleged sprain persist over an unusually long period, when no limitation of movement suggesting adhesions is present, when all other causes have been excluded (a radiograph being never omitted), and when manipulation followed by a course of re-education of the wasted muscles fails to cure the condition. In such a set of conditions, exploratory arthrotomy is certainly justifiable.

The differential diagnosis between chronic sprain of the deep fibres of the internal lateral ligament and a lesion of the middle third of the internal semilunar cartilage is often very difficult. In the latter condition the eliciting of cartilage crepitus is pathognomonic and can be obtained as follows. with the tip of the index finger press firmly over the joint interval at the level of the internal lateral ligament. While maintaining deep pressure with the finger, flex the knee-joint and at the same time rotate the leg inwards and outwards several times. Quite suddenly one may feel a whip-cord-like structure (the torn internal semilunar) move under the finger, and one can trap it and roll it against the underlying head of the tibia with a loud snap.

Far too many cases are labelled chronic strain of internal lateral ligament and are treated indefinitely with physiotherapy, when in reality a torn cartilage is present which could be cured by removal. (See Case I, p. 116.)

To sum up, diagnosis between sprain of the deep fibres of the lateral ligament alone and a lesion of the corresponding meniscus must rest upon an accurate and painstaking history and thorough and purposive examination of the knee-joint. The position of maximum tenderness helps in some cases, but is often fallacious. There is a type of case in which it is impossible, having excluded other forms of internal derangement, to say whether a patient is suffering from the sequelæ of sprain or from one of the less common types of lesion of the internal meniscus.

Treatment in such cases may well be upon the following lines The position should be explained to the patient and manipulation advised in the first place. If this measure fails, exploratory operation is indicated.*

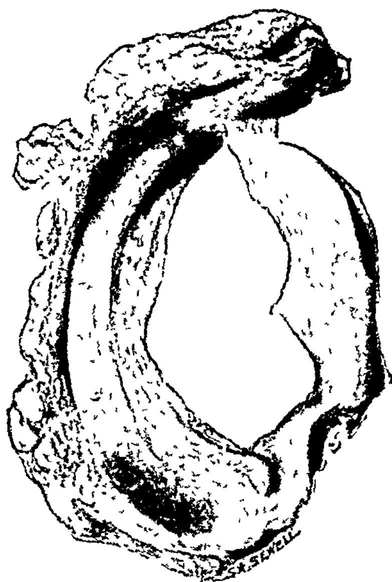


FIG 46 — TYPICAL "BUCKET-HANDLE" LESION OF INTERNAL SEMILUNAR CARTILAGE

The strip of cartilage to the right of the drawing is known as the "handle" of the "bucket"

(Museum of the Royal College of Surgeons of England Specimen presented by the author)

Manipulation in Chronic Cases of Semilunar Cartilage Derangement.

It is important to bear in mind that the commonest lesion of a semilunar cartilage is the complete longitudinal tear or "bucket-handle" type (47·54 per cent. in author's series), and the characteristic symptoms in many chronic cases are due to the behaviour of the fractured portion or "handle" of the "bucket" (Fig. 46).

Other types of fracture of the semilunar cartilage are, however,

* Air arthrography is considered by some to be of value in differential diagnosis in the doubtful cases The latter should be rare if clinical examination is thorough and with the growth of experience (Cullen and Chance, *Brit Jour. of Surgery*, 1943, vol. xxx, p 241.)

frequently encountered, such as lesions of the anterior third (27·86 per cent.) and of the posterior third (13·93 per cent.), and in these cases the symptoms are also due to the behaviour of the fractured portion. In all of these lesions, when healing of the original fracture has not taken place, the fractured surfaces are smooth and covered by fibrous tissue and the possibility of ultimate union becomes negligible.

This accounts for the frequency with which the original fracture of the semilunar cartilage is followed by recurrence of symptoms and particularly by repeated attacks of mechanical locking.

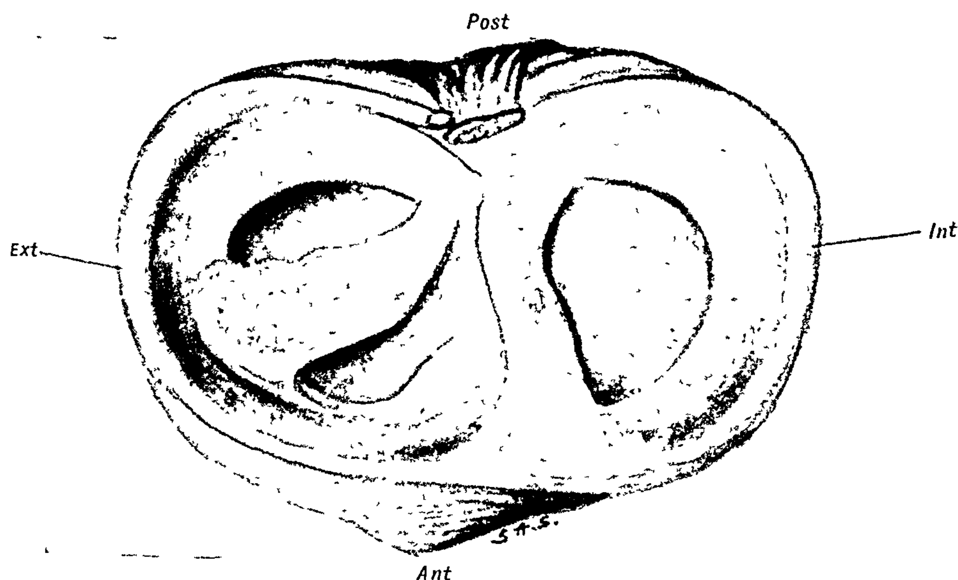


FIG 47.

A complete longitudinal tear of the internal semilunar cartilage (Int) is present, the outer fragment (H) lying in the intercondylar region. A longitudinal tear of the posterior half of the external semilunar cartilage (Ext) is present, the inner fragment of which occupies an intermediate position. For history see text, p 117 (Case II).

If a recurrent attack of locking occurs which fails to rectify itself, either by the efforts of the patient or otherwise, the surgeon may treat this by manipulative replacement as in original lesions associated with locking. This should, however, be regarded as a temporary measure only, and the patient should be warned that the presence of a torn meniscus in the knee-joint which gives rise to recurrent symptoms is apt to bring about arthritic changes, and that removal of the offending cartilage by skilled hands is the best insurance against this sequel. If this advice is accepted, it may be more

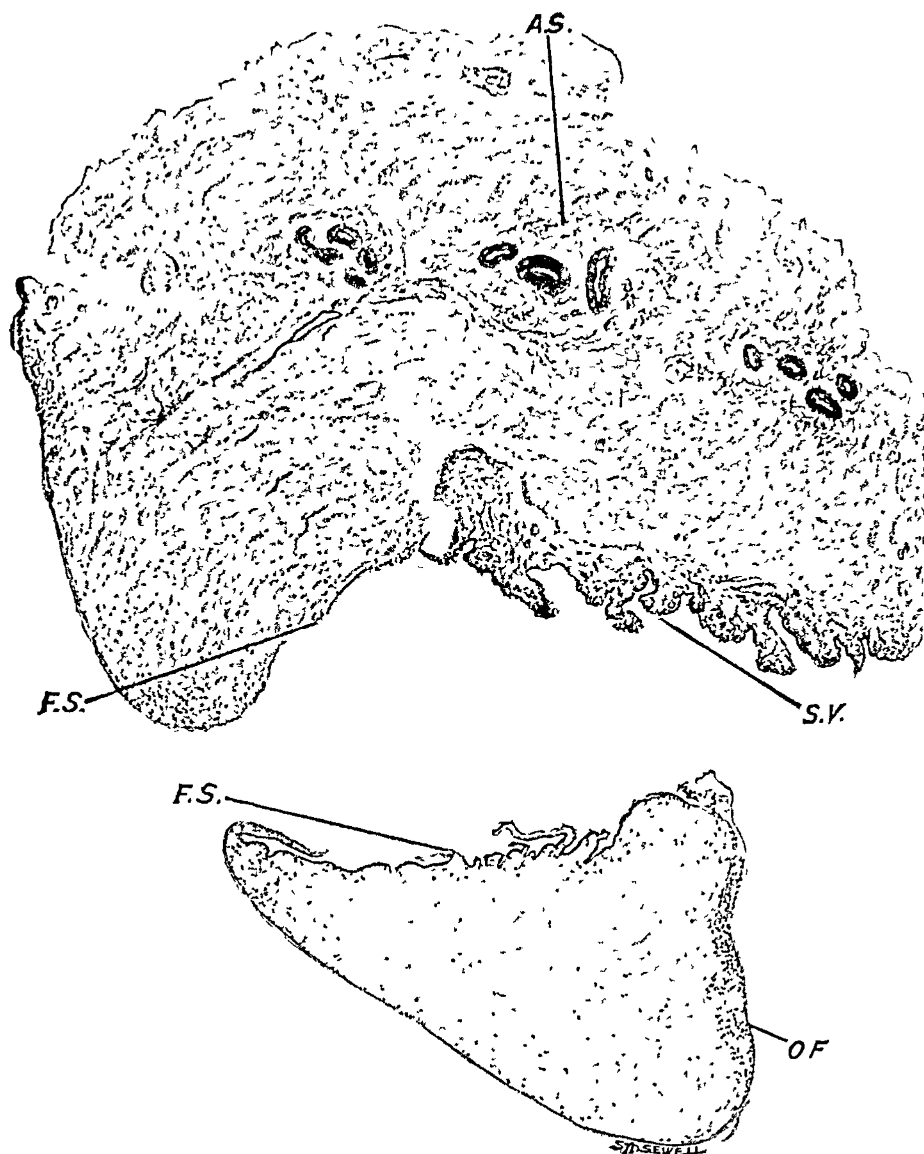


FIG 48 —TRANSVERSE SECTION OF BOTH PORTIONS OF A BUCKET-HANDLE LESION OF THE INTERNAL SEMILUNAR CARTILAGE

A S =Attached surface of inner fragment showing bloodvessels
O F =Outer fragment (handle of the "bucket") showing absence of bloodvessels
S V =Synovial villi
F S =Fractured surfaces Repair is more advanced in that of the more vascular inner fragment In the fractured surface of the outer fragment there is very little attempt at repair

convenient to remove the semilunar cartilage forthwith without preliminary manipulation, thus avoiding two anæsthetics.

The risk of arthritis supervening in neglected cases can hardly be over-emphasised. Patients often refuse operation owing to the minor inconvenience of momentary attacks of locking until symptoms of arthritis supervene, when the ideal time for operation has passed for ever.* In such neglected cases, operation will probably cure the attacks of locking, and hence may be advisable, and it may prevent or delay the onset of generalised changes. The patient

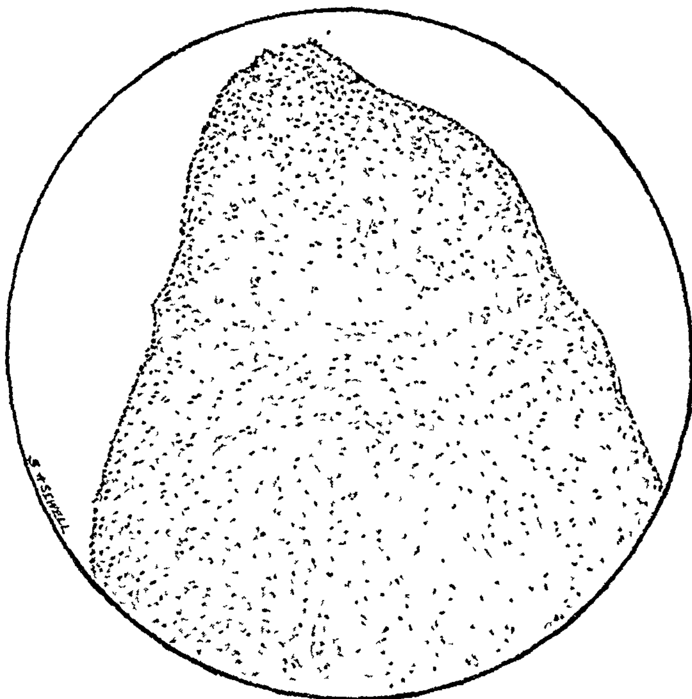


FIG 49—INTERNAL SEMILUNAR CARTILAGE TRANSVERSE MIC SECTION OF FRACTURED PORTION, SHOWING SMOOTH ENDOTHELIALISED SURFACE

should be warned, however, that owing to the presence of arthritis, absolute freedom from symptoms cannot be anticipated.

A very important question now demands discussion.

Is it possible, as some bone-setters claim, to bring about by manipulation a radical cure of a chronic lesion of a semilunar cartilage? The words "radical cure" imply a complete and permanent cessation of all symptoms, but for the reasons given above complete cure

* In a surprisingly large number of cases the patient refrains from having an operation because of the deeply rooted idea that still exists in the public mind that operation will lead to a "stiff knee."

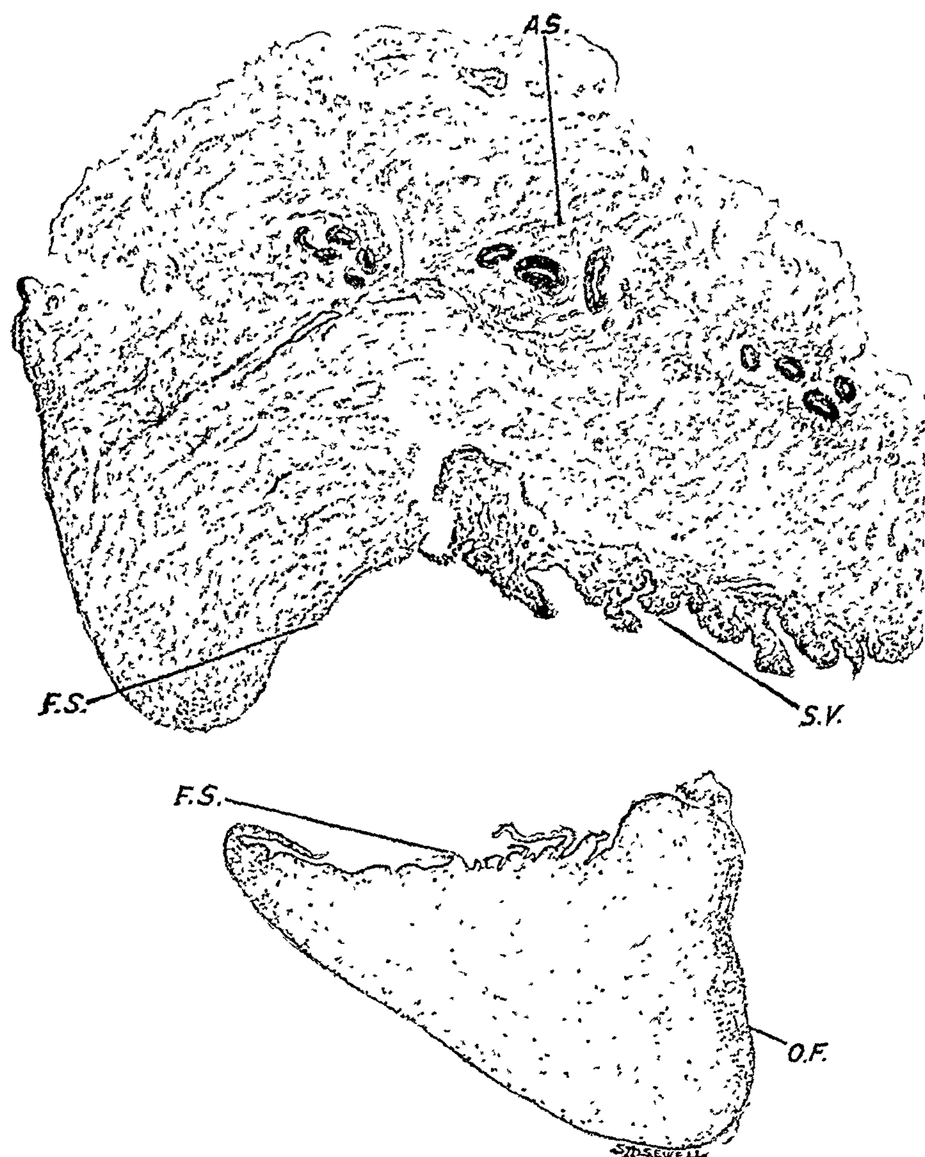


FIG 48 —TRANSVERSE SECTION OF BOTH PORTIONS OF A BUCKET-HANDLE LESION OF THE INTERNAL SEMILUNAR CARTILAGE

A S =Attached surface of inner fragment showing bloodvessels.
O F =Outer fragment (handle of the "bucket") showing absence of bloodvessels
S V =Synovial villi
F S =Fractured surfaces Repair is more advanced in that of the more vascular inner fragment In the fractured surface of the outer fragment there is very little attempt at repair.

described later, but an important point is to extend the knee somewhat forcibly, and to pay particular attention to the "screw-home" movement at the end of extension. This movement probably converts the partial into the complete bucket-handle type of lesion, and in injuries and minor displacements of the anterior half of the semilunar forces the latter firmly into position.

Example of lesion of semilunar cartilage with recurrent symptoms improved by manipulation:

CASE.—Mrs. L, aged 50, complained of frequent "giving way" with occasional mechanical "locking" of her left knee, the last occasion being a month previously. She presented the classical history, signs and symptoms of a torn internal semilunar cartilage of long standing, with recurring displacement. These symptoms had been present for no less than thirty-seven years. Each attack of "locking" was followed by marked pain and swelling which necessitated her lying up for three or four weeks at a time Apparatus had been worn in vain X-rays showed slight traumatic osteo-arthritis The patient declined operative removal of the semilunar cartilage; but as she was anxious that something should be done to prevent the frequent "giving way" and locking, it was decided to have recourse to manipulation. Manipulation was accordingly successfully performed under gas, particular attention being paid to the "screw-home" movement at the end of extension.

Some Further Conditions of Semilunar Cartilage and Pad Amenable to Manipulation.

There is a group of conditions that interfere with the normal "screw-home" movement of the inner femoral condyle, and which are amenable to treatment by manipulation. These are:

(*a*) Minor displacements of the anterior half of the internal semilunar cartilage due to stretching or tearing of the coronary attachment.

(*b*) Inflammatory induration of the alar process of the infrapatellar pad of fat (semilunar pad), with adhesions in connection with the latter process.

(*a*) **Minor Displacements of the Anterior Horn of the Internal Semilunar.**—To refer briefly to the anatomy of this important region. If a transverse section be made through the knee-joint at the level of the semilunar cartilages, it will be seen that the internal semilunar, in addition to its attachment to the true capsule, is firmly adherent to the deep fibres of the internal lateral ligament, and behind this to the aponeurotic layer. The anterior half of the

of chronic lesions of the semilunar cartilages by manipulation alone must be of rare occurrence.

Even if we assume that by manipulation it is possible to place these long-standing fractured surfaces in apposition, it would surely be difficult to find conditions more unfavourable for repair.

How, then, can we explain the temporary cessation of recurrent attacks of locking in certain types of fractured semilunar cartilage of long standing that may occur after manipulation?

It has been observed that the bucket-handle lesion is the commonest type of fracture of the semilunar cartilage. At operation, the "handle" of the "bucket" may often be seen lying wedged in the intercondylar space between the edge of the femoral condyle and the anterior crucial ligament, in which position it has not necessarily given rise to limitation of extension or attacks of locking.

It appears, therefore, that the probable explanation of apparent "cures" by manipulation of recurrent attacks of locking due to semilunar cartilage lesions is as follows.

(*a*) The lesion was probably of the "bucket-handle" type, and often incomplete.

(*b*) The handle of the bucket, being incomplete, previously occupied some position between the condyles of the femur and tibia, causing frequent mechanical locking.

(*c*) During the manipulation the bucket-handle lesion was rendered complete, and the handle of the bucket was firmly forced into the centre of the joint between the femoral condyle and the anterior crucial ligament.

In chronic types of fracture of the semilunar cartilage other than the "bucket handle," it is clear that *temporary* benefit may well result also if by manipulation the fractured portion is forced into some area of the joint where it is less likely than before to impinge between the articular surfaces.

From observation of cases of this type that have been so treated by manipulation it is, however, clear that in the majority of such cases the "cure" is not lasting, and that sooner or later there is a recurrence of symptoms, particularly if the knee is subjected to any strenuous test.

Removal of the offending cartilage, if not too long delayed, is in expert hands one of the most satisfactory operations in surgery, and this course should always be advised, particularly in those whose work or play is of a strenuous nature

If, however, a patient refuses the operation of removal, or if circumstances make this inadvisable, manipulation is worthy of trial, if its uncertainty is explained to the patient. The technique will be

between July, 1942, and June, 1944, he had seven setbacks, which occurred for no apparent reason; once, for instance, when walking slowly along a level passage. There was no sharp stab of pain, but he had a sensation of something grating or giving-way in the knee. After each attack the knee remained painful and swollen for several weeks.

At the beginning of this series of relapses he consulted an osteopath on several occasions, by whom the knee was manipulated twice without benefit. During this two-year period he also consulted six medical men, including two orthopædic surgeons Many different diagnoses were made, but no operation was advised. X-rays threw no light on the condition. For two years he had been forced to live a sedentary life, for most of the time almost completely crippled, and his mental condition was becoming serious.

On examination of the left knee in June, 1944, I found movements full, no joint effusion, and 1 inch wasting of the left thigh. On deep palpation of the joint interval on the inner side during flexion and rotation, a torn fragment of the internal semilunar cartilage was felt just anterior to the internal lateral ligament It was trapped by the fingers and rolled against the tibial head with a loud snap that could be heard all over the room

The suggestion of operation was accepted at once and with relief, and two weeks later I removed a badly torn internal semilunar cartilage with a long and narrow pedunculated flap of cartilage attached to the inner border. The operation was uneventful except for the close passage of a flying bomb over the roof of the theatre. Since the operation the patient has been completely free from symptoms and has lived a normal life

Case II —A young woman, while playing lacrosse, turned suddenly and twisted her right knee. She stated that this was accompanied by a "snap" on the inner side of the joint She was unable to continue playing, and joint effusion occurred almost immediately. There was apparently no mechanical locking on this occasion The joint was treated by rest and compression for three weeks, and the swelling almost entirely subsided One month later, the knee gave way again on the inner side without locking or effusion

She consulted a bone-setter, who performed manipulation. She was free from trouble for six months, but then, while dancing, the knee gave way on the outer side, with definite mechanical locking She again consulted the bone-setter, who restored free movement Afterwards, however, the joint frequently gave way on the outer side after any twisting movement, often with true mechanical locking, which, however, was of short duration This happened several times daily. She wore for some time various knee-caps and mechanical supports, which, however, were useless

At operation the condition was found which is represented in Fig. 47.

cartilage, however, is separated from the aponeurotic layer by a well-marked interval filled with loose fatty tissue, and the periphery is attached to the margin of the internal tibial condyle by a portion of the true capsule, known as the coronary ligament. A weak mechanical site therefore exists at the spot where the mobile anterior half meets the more fixed posterior half, opposite the level of the internal lateral ligament. A sudden twist inwards of the femur upon the fixed tibia with the knee slightly flexed may, without causing a definite tear of the cartilage or of its anterior attachment, cause a partial rupture of the coronary attachment and a minor displacement. This is insufficient to cause obvious locking, but a feeling of discomfort on full extension occurs, and this movement may be limited by a few degrees.

(*b*) **The Semilunar Extensions of the Infrapatellar Pad of Fat.**—In the investigation of a number of formalin-hardened knee-joints the author found that the anterior third of the internal semilunar cartilage was usually protected by a process of the infrapatellar pad of fat, upon which the important screw-home movement of the internal femoral condyle occurs at the termination of extension. This process is frequently injured, either alone or simultaneously with injury to the anterior end of the internal semilunar. Although the process is so important clinically, it has not been considered worthy of a name, although it is often wrongly called the inner alar pad Possibly " semilunar process " or " pad " might be a better name In some cases in which it is considered that a lesion of the cartilage is present, it is really this process which is at fault. A lesion of the process may be followed by the formation of adhesions between it and the cartilage, or some other adjacent structure.

Manipulation in this group is a valuable measure, and particular attention should be paid to the " screw-home " movement at the end of extension.

Illustrative Cases of Semilunar Lesion.—It is not proposed to discuss the surgery of the semilunar cartilages, except in so far as the question of manipulation is concerned

Some of the important points in the clinical history and pathology of chronic lesions of the semilunar cartilages, in each of which operation was necessary after the failure of preliminary manipulation, are shown by the following cases

CASE I.—J. N., aged 51, consulted the author in June, 1944, and gave the following history He " displaced a cartilage " in the left knee in August, 1937 This was replaced by a Park Lane bone-setter seven weeks later. The knee became " perfectly normal " after four months and remained so for five years Then his troubles began, for

One week later manipulation was performed, followed by re-education of the thigh muscles.

The improvement that followed was only temporary, and two months later operation was performed. A complete longitudinal tear of the internal semilunar was seen to be present, with the outer portion actually lying in the intercondylar notch (Fig. 46).

The meniscus was completely removed.

CASE V.—The particulars of this case were kindly supplied to me by the late Mr. Graeme Anderson It is of particular interest, since the patient's knee was manipulated three times—once by a surgeon and twice by a well-known bone-setter—before operation was successfully performed by the author's patella-displacing method.*

Pilot Officer A. T., aged 20

History—Twisted left knee playing rugby football and was in bed for eight weeks History of locking. Later, on attempting to play games, the knee gave way, with subsequent swelling and pain.

Knee manipulated under gas; no improvement.

Went to bone-setter, who manipulated; no improvement.

Repeated; no improvement.

Third offer to manipulate declined.

Admitted to hospital two and a half years after original accident. No swelling, no tenderness, but marked lateral mobility, and wasting of quadriceps

Operation. Joint opened by Timbrell Fisher's patella-displacing approach. Internal cartilage found detached in anterior part. Whole removed, external cartilage found loose along lateral edge, but attached fore and aft, displaced like a bucket handle underneath external condyle of femur (convexity of bucket handle pointing inwards).

External cartilage removed; no drainage, healed well.

Patient seen one year later.

Full movement of knee; no lateral mobility, no effusion, no pain, has played tennis and squash, asked permission to play hockey and rugby football. Granted

It is interesting to note from the above case-histories that when the handle of the complete bucket-handle lesion lies in the interior of the joint, where it may have been forced by manipulation, symptoms may still persist although attacks of locking may cease. *The obvious conclusion is that removal by operation of the fractured cartilage in recurrent cases of semilunar cartilage lesion is the only method of treatment that holds promise of a permanent cure.*

* This exposure is unnecessarily extensive for uncomplicated semilunar cartilage cases but is of value if a more complete exposure is desirable.

A complete longitudinal fracture of the bucket-handle type of the internal semilunar cartilage is present, the outer portion of which is situated in the intercondylar region. A longitudinal fracture of the posterior half of the external semilunar cartilage is present, the inner part of which occupies an intermediate position.

It seems clear that the first manipulation by the bone-setter forced the fractured portion of the internal cartilage towards the interior of the joint, where it gave rise to no further obvious trouble

The intermediate position of the fractured portion of the external semilunar was clearly the cause of the frequent "giving-way" upon the outer side of the joint following the second manipulation.

CASE III —L. W, aged 26, gave the following history. Eight weeks previously he severely twisted the left knee, the thigh being rotated forcibly inwards upon the leg, which was slightly flexed and abducted He experienced severe pain upon the inner side of the joint, and fell Definite mechanical locking occurred, which was rectified by manipulation. He now stated that the knee frequently gave way and caused him to fall, but no true locking occurred The knee had remained slightly swollen, but each attack of giving-way had been followed by increased swelling.

On Examination.—Synovial effusion was present, and tenderness over the anterior and middle of the inner surface of the internal semilunar cartilage, and over the inner border of the tibia immediately to the inner side of the patellar ligament. Movements were full, there being no limitation of full extension. Definite wasting of the quadriceps was present.

At operation a complete longitudinal tear of the internal meniscus was found to be present, with the outer fragment (handle of the bucket-handle lesion) lying in the interior of the joint between the crucial ligament and the inner femoral condyle

In this case it is probable that the original manipulation had driven the fractured portion still further into the interior of the joint, where, although the locking was reduced, it still gave rise to disability.

CASE IV —H F., aged 42, a dock worker, struck the inner side of his left knee against the hand-rail of a barge.

The knee swelled up almost immediately, and was locked with a mechanical block to full extension The displacement was reduced at hospital, and he was treated for a few weeks with rest, compression bandage, and massage

Six months later he complained of pain on the inner and posterior aspect of the joint, and recurrent synovial effusions after exercise

On Examination—Movements were full. Localised tenderness was present over the middle of the inner surface of the internal semilunar. Synovial effusion of moderate amount was present, and ¾ inch wasting of the left thigh.

On examination, one year after the accident, considerable synovial effusion was present, with a thickening of the joint capsule. Flexion was limited by 15 degrees and painful, extension was full, and there was no lateral mobility Slight swelling of the leg and ankle were present. X-ray examination did not show any evidence of involvement of the articular surfaces.

This was considered a case of traumatic synovitis upon which a toxic element had become superadded.

It was decided that an attempt should first be made by various methods of physical treatment to increase the range of flexion. Later, by manipulation under gas, full flexion was obtained, and there was a marked improvement in the condition of the joint.

CASE II.—Major —— severely injured his right knee in India through being run over by a gun-carriage. Marked swelling followed, which gradually subsided, and he resumed all his usual activities.

Four years later he began to notice recurrent attacks of painful swelling of the joint. He consulted a doctor, who informed him that he was suffering from rheumatoid arthritis He was ordered a leather orthopædic apparatus, which kept the knee rigidly extended. Under this treatment the pain became worse.

On Examination.—A typical condition of villous synovitis was found to be present, with painful limitation of full flexion. X-ray showed evidence of an old injury to the tibial tubercle, but no involvement of the articular surfaces. A diagnosis of toxic synovitis supervening upon an old injury of the joint was made.

Manipulation was performed with satisfactory results. Pain and limitation of movement disappeared, and he was able to play games without any ill-effects

He wrote. "My knee is progressing splendidly. I can bend it to an acute angle without pain or difficulty I have gained a new lease of life."

It is a melancholy reflection that there must be many patients who are quite unnecessarily condemned to prolonged disablement by failure to appreciate the possibilities of manipulation in this type of case and in the next to be described.

Manipulation in Arthritis of the Rheumatoid and Osteo-Arthritic Types of the Knee-Joint.

In chronic arthritis of the rheumatoid and osteo-arthritic types, in which the articular surfaces are also involved, the principle of preserving movement in the earlier stages, if this is possible, should be observed In these chronic cases, Nature is endeavouring in a remarkable way to form a new joint, and the patient, if possessed of the necessary determination, can assist the process materially.

Manipulation in Toxic or Infective Synovitis of the Knee-Joint.

These conditions are very liable to follow any of the above-mentioned injuries of the knee in persons past the meridian of life.*

The remarks made at the commencement of this book concerning the misapplication of rest are also relevant to this group of conditions

The acute or subacute stages lead in most cases to a certain amount of painful limitation of movement due to intra- and peri-articular adhesions

Unfortunately, the symptoms due to the presence of these adhesions in the quiescent stage are sometimes mistaken for evidence of active disease, and it often happens that the patient receives every conceivable form of treatment and wanders disconsolately from one treatment centre to another with the knee fixed in an uncomfortable and expensive apparatus, while the movement for which the joint is clamouring is withheld.

When such a joint is fixed, it is physiologically placed at the greatest disadvantage to combat any smouldering infection that may be present, for the circulation not only of blood, but of lymph, and the secretion and absorption of the synovial fluid depend upon regular movement. When complete rest is enjoined, the circulation in the joint becomes a stagnant backwater and the synovial cavity a kind of cesspool to which phagocytes and antibodies cannot obtain access. Muscular wasting is always a prominent feature.

One of the principal complaints in this disease is of stiffness and discomfort of the joint after the night's rest, or after sitting still for some time, which disappears after exercise. Over-exertion is, of course, to be carefully avoided, but the practice of completely *immobilising the joint in such cases is contrary to the dictates of* reason or even of common sense.

Illustrative Cases.—These cases illustrate some of the unsatisfactory results of immobilisation in apparatus, and the marked improvement often obtained by manipulation.

CASE I —A woman fell down some steps and "sprained her knee" Very marked bruising and swelling followed Early massage and passive movements were instituted, and continued for some months A radiograph taken three months after the injury showed that there had been a vertical split fracture of the tibial head in the region of the tibial spine. She had been previously treated for a rheumatoid condition of both knees Considerable swelling, weakness, and limitation of movement persisted, and she was ordered a celluloid splint to limit movement. This she found uncomfortable, and discarded, as pain and discomfort were increased by immobility

* See the author's "Chronic (Non-Tuberculous) Arthritis" (H K. Lewis and Co , Ltd)

As the surgeon's interest and experience in manipulative work grows, it will nearly always be found that he performs a steadily diminishing number of arthrodeses and excisions

Illustrative case of manipulation of the knee in arthritis of the osteo-arthritic type.

Mr. H, aged 65, complained of pain, weakness, and stiffness of the left knee of ten months' duration. The onset was somewhat sudden, acute, and associated with painful synovial effusion, which, however, subsided with treatment.

Examination revealed typical osteo-arthritis of the left knee, which was confirmed by X-ray examination. No effusion was present, but flexion was limited by 25 degrees and extension by 15 degrees, and there was a moderate degree of wasting of the thigh muscles. It was considered probable that the osteo-arthritic changes had been present for some considerable time, and that the attack of synovitis had led to the formation of adhesions with resulting restriction of movement The patient had been prescribed the usual medical treatment and a long course of physiotherapy in the form of radiant heat and ionisation without any definite improvement Manipulation was performed under anæsthesia and full movement obtained. This was immediately followed up by special exercises to maintain the increased range of movement and improve the condition of the muscles. Ten weeks later the patient wrote from Scotland: " My knee is quite 90 per cent. better. I can bicycle again in moderation, and I am fishing and *wading*, and it does not seem to do any harm, but rather the knee is all the better for it !"

Rheumatoid Type.

In Chapter III mention has been made of the prevention and treatment of deformity in the earlier and more acute stages of the rheumatoid type of arthritis of the knee-joint When these methods have not been adopted or have not succeeded completely, manipulation has, as has already been mentioned, an extremely valuable and important rôle in correcting such deformities of the knee-joint. For technique employed in cases of this nature see pages 128-137.

Illustrative Cases.

Case I.—Mrs N. First seen in June, 1945 Had been unable to walk for ten years owing to extreme flexion deformity of both knees, and her husband carried her about everywhere like a sack of coals over his shoulder.

Fifteen years ago, generalised arthritis of the rheumatoid type developed after a pregnancy and a severe mental shock. The joints of both upper extremities were first involved, and two years later the knees and ankles were affected. She was given gold injections with benefit

Osteo-Arthritic Type.

The author has endeavoured to show that a fundamental feature is degeneration of the poorly nourished central area of the articular cartilage, and proliferation, which is often compensatory, of the better-nourished lateral portions, whereby chondro-osteophytes are formed.* Nature makes good the loss of the central part of the articular cartilage by sclerosis and eburnation of the subarticular bone, and the chondro-osteophytes extend the articular surface. But eburnation depends upon movement, and it should be our aim to guide and utilise the natural processes of repair and assist them by modern methods of physical treatment and by clinical judgment. If regular movements through complete range are maintained from the first, the following benefits result

1. Contracture by scar-tissue, both intra- and extra-articular, with painful limitation of movement, is prevented or minimised.
2. Mechanical obstruction of movement by osteophytes is also reduced to a minimum
3. The process of eburnation is materially assisted.
4. Muscle tone is preserved.
5. The nutrition of the joint structures is maintained.

Many persons are able to live active lives when all the evidence points to the fact that the articular cartilage in the affected joint has been largely destroyed and Nature's cure by eburnation of the articular surfaces has occurred

When these principles have been neglected and painful limitation of movement by scar-tissue has occurred, often associated with recurrent joint effusions, an effort should always be made in the first place to improve the range of movement by manipulation

It is often assumed that, if marked osteophytes are present, nothing short of open operation can be of any avail. However, it is surprising to find in many of these cases that the limitation of movement actually due to osteophytes is comparatively unimportant, and that by manipulation a marked increase of movement may be obtained

The formation of a fixed joint by excision in this type of case is often advised, but this should only be performed as a last resort.

Arthrodesis and excision have a definite place in the surgical treatment of chronic arthritis, but they should never be lightly undertaken, and may be reserved for cases in which manipulation and other measures to preserve a movable joint have failed, or pain is unusually acute.

* "A Contribution to the Pathology and Ætiology of Osteo-arthritis," Hunterian Lecture delivered at the Royal College of Surgeons of England, *Brit. Jour. of Surgery*, 1922-23, vol x, pp 52-80

CASE III.—Miss P., aged 23, a children's nurse Complained of pain and stiffness of the right knee of nine months' duration. She walked with a marked limp and complained of weakness of the limb. Eighteen months previously she had suffered from acute brachial neuritis, which persisted for many weeks. Nine months before being sent for treatment she developed arthritis of the right knee of the rheumatoid type, for which she was treated for three months at a well-known spa. X-rays showed no abnormality; occasional evening temperature occurred. In addition to various forms of treatment by vaccines, drugs, etc , the limb

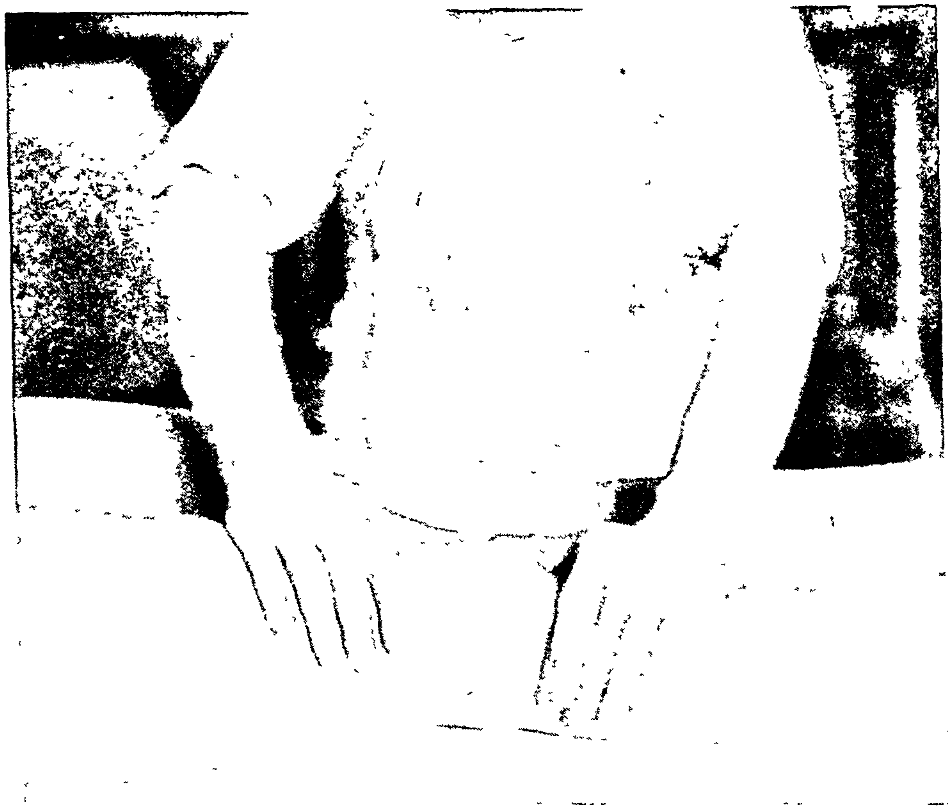


FIG 50 —MOBILISATION OF RIGHT PATELLA

had been immobilised for the greater part of the time by means of a splint.

On Examination —The right knee presented swelling, due to thickening of synovial membrane and to peri-articular changes Movement within a limited range was painless, but beyond this point was restricted and painful Generalised tenderness of the joint was present, but the skin surface over the joint was cool. A moderate degree of wasting of the right thigh was present

The case was clearly one of monarticular arthritis of the rheumatoid

particularly to the joints of the upper extremities, but the knees became more and more flexed

On Examination.—Both knees maintained at angle of 100 degrees flexion Thirty degrees of flexion possible beyond this point, but no extension Ankles and feet normal The mental condition of the patient was excellent and she was cheerful and full of hope

June 22, 1945 First manipulation of knees under anæsthesia Gratifying improvement of extension of knees obtained—*i e*, to angle of 140 degrees Plasters applied and bivalved after a few days for re-education of thigh muscles, particularly quadriceps extensors.

June 28, 1945 Second manipulation under anæsthesia Further appreciable improvement in extension of knees—*i e*, to 165 degrees. Fresh plasters applied and bivalved as before for quadriceps re-education

July 8, 1945 Walked a few steps with assistance for the first time for ten years

July 24, 1945. Third manipulation under anæsthesia similar after-treatment

August 26, 1945. Left nursing home wearing plaster casts to knees and arrangements made for after-treatment to continue

May 13, 1946. Reported again. *Walked into consulting room unaided* Is even able to walk a little without sticks and with sticks about a mile. Extension of knees still not quite complete, being limited by about 25 degrees Further manipulation under anæsthesia advised

May 27, 1946 Manipulation of both knees under anæsthetic Extension improved by a further 15 degrees Plasters applied and bivalved a few days later and after-treatment commenced

June 15, 1946 Progress very satisfactory. Returned home walking much better and with instructions to continue re-educational exercises

CASE II.—Miss B., aged 65 Complained of pain, weakness, swelling, and stiffness of the left knee, and walked with a marked limp. She stated that these symptoms had been present for seven years, and had been steadily increasing She had visited many spas, both in this country and on the Continent, without relief

Examination showed chronic arthritis of the rheumatoid type, with limitation of flexion of the knee by 30 degrees, and a moderate degree of wasting of the thigh muscles X-ray revealed slight involvement of the articular surfaces Manipulation was performed under gas anæsthesia, and the usual after-treatment followed Two months later the patient wrote "I have purposely postponed writing to you before, as I wished to give my knee a real testing time It is now two months since the manipulation, and I am glad to say that the knee has been behaving very well I have had no return of pain, stiffness, or swelling, and I walk without any limp, even going downhill is fairly easy, and I go up and down stairs in the normal way"

Miss P. S., aged 27, while undergoing training as a nurse, noticed pain in the right knee on going upstairs after a long period of duty. This steadily increased, but no swelling was ever noticed. The condition was considered to be of infective origin, the tonsils and also two suspicious teeth were removed, and she was recommended to rest the limb and to wear a back-splint with foot-piece. This was worn for six months, and caused the pain to disappear. At the end of this period



FIG 52 —MANIPULATION OF RIGHT KNEE TO CORRECT LIMITATION OF FLEXION.

she began to get about on crutches, and a few months later a calliper splint was substituted At about this time, pain and slight swelling were noticed in the left knee, and she was recommended to wear a calliper splint for this joint also The joints were X-rayed twice, with negative results

On Examination—Right Knee—No swelling, but tenderness over internal femoral condyle, and over middle of inner surface of internal semilunar cartilage Marked limitation of movement, most of which

type in which the infection had "burnt itself out," but left a joint crippled by adhesions

Manipulation of the joint was performed under gas anæsthesia and full movement obtained without difficulty Many adhesions were heard to rupture during the procedure. Radiant heat, massage, and graduated exercises were instituted immediately and carried out daily. No pain or increased swelling followed the manipulation. A fortnight later she was walking without a limp, was free from pain, and had full movement in the knee. The improvement has been steadily maintained

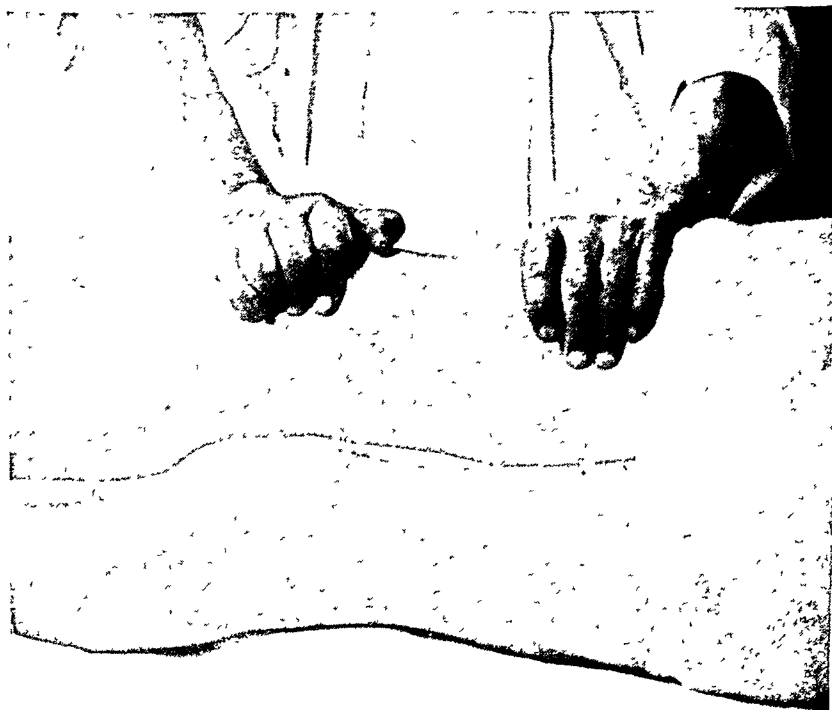


FIG 51 —MOBILISATION OF RIGHT PATELLA SECOND METHOD

Manipulation in Functional Disorders of the Knee-Joint.

Although we have placed this group at the end of our list, it is one in which excellent results can often be achieved by attention to the principles that have already been described. It is unnecessary to repeat these, and it will suffice to illustrate the treatment of this group by a typical case.

Illustrative Case.—Manipulation of knee, functional type, probably superimposed upon transient synovitis of organic basis.

pad of fat are mobilised. This step should be carried out in every case, and is particularly indicated in cases where the adhesions are at all dense; for if flexion be carried out without preliminary mobilisation of the patella, fracture of the latter or severe injury to some part of the extensor apparatus may occur. The surgeon's two thumbs are placed first upon the inner and then upon the outer side of the patella and the bone moved from side to side. The process is next repeated in relation to the upper border and apex of the patella, and movement upwards and downwards performed. This process is



FIG 54 —MANIPULATION OF KNEE (RIGHT) TO CORRECT A SLIGHT OR MODERATE DEGREE OF LIMITATION OF EXTENSION

repeated over the infrapatellar pad of fat Adhesions in the region of the latter process are of frequent occurrence, and it is probable that this technique is sufficient to rupture those of a minor nature.

Another method is to grasp the patella with the right hand so that the thenar eminence is in contact with the outer border of the patella while the fingers grasp the inner border. The patella is then firmly grasped and moved from side to side (Fig. 51).

(*b*) *Flexion and Extension.*—The technique differs according to whether the adhesions are slight or dense.

appeared to be due to reflex muscular spasm. Considerable wasting of thigh muscles.

Left Knee —Tenderness as above Slight limitation of flexion only

The general condition was good, and there was nothing of importance to note in her previous history. There was no affection of any other joint Manipulation was performed under gas and oxygen anæsthesia, followed by immediate re-education In the case of the right knee, movement to an angle of 80 degrees was obtained very easily, after which some resistance was encountered owing to adhesions. These

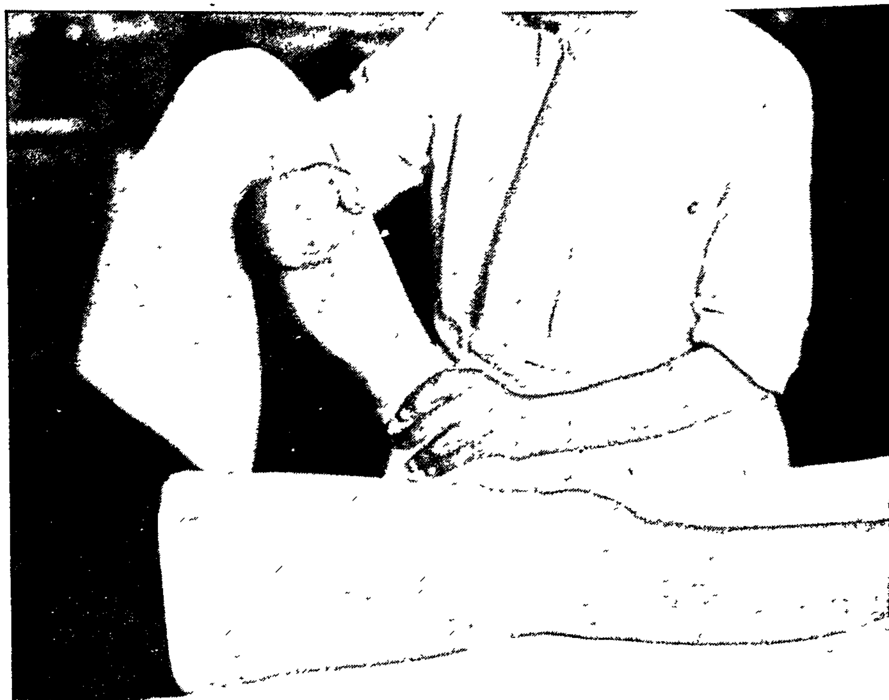


FIG 53 —FORWARD LEVERAGE OF HEAD OF TIBIA (LEFT)

yielded with the exercise of a moderate degree of force, and full flexion was obtained In the case of the left knee, full movement was obtained with great ease, such limitation as was previously present having been obviously due to spasm

Result —The patient made a complete and almost immediate recovery. Eight days later she walked five miles without the aid of a stick, and without the slightest subsequent discomfort In a fortnight she was playing tennis and other games without ill-effects

Manipulative Technique—(*a*) *Mobilisation of Patella* (Figs. 50 and 51).—With the leg fully extended, the patella and infrapatellar

extension be limited, the limb is lowered and the surgeon steadily extends by firm pressure with both hands upon the front of the joint (Fig. 54) while his assistant applies traction to the leg, or one hand may grasp the foot while the other exerts counter-pressure upon the front of the lower third of the thigh. In some cases there is interference with the normal "screw-home" movement at the end of



FIG 56 —METHOD OF MANIPULATION OF KNEE (LEFT) TO CORRECT LIMITATION OF FLEXION DUE TO DENSE ADHESIONS

extension, and, in such, particular attention should be paid to external rotation of the tibia at the termination of extension.

Another method of correcting limitation of extension of slight or moderate degree is illustrated in Fig. 55.

More Marked Adhesions.—When performing manipulation of a knee-joint in which limitation of movement by adhesions is of a more obstinate type, it is important to bear in mind that the move-

Slight Adhesions.—In the case of the right knee, the surgeon grasps the patient's knee with his left hand and the lower third of the leg just above the ankle with the right hand (Fig. 52). Then, while maintaining firm pressure with the fingers of the left hand upon any particular spot of tenderness that is considered to indicate an adhesion, a series of rapid but purposive flexion movements are performed, and often a definite snap indicates the rupture of the



FIG 55.—MANIPULATION OF KNEE (RIGHT) TO CORRECT A SLIGHT OR MODERATE LIMITATION OF EXTENSION ALTERNATIVE METHOD

adhesion, and full movement is restored. Next, rotatory movements are performed in the following manner: The knee is fully flexed and rotated inwards and outwards and then gradually extended, and during the latter movement a series of quick rotatory movements, both inwards and outwards, are performed. Care must be exercised during the latter movements to avoid the exercise of undue force, as this may cause severe sprain of the lateral ligaments, or even damage to one of the semilunar cartilages The tibia is then levered forwards by flexion over the operator's forearm in the popliteal space (Fig. 53, where, however, the left knee is illustrated). If

The golden rule is, "When in doubt, stop." It is far wiser to rest content with a slight but definite increase of range, to decide upon a further manipulation later, and to consolidate the position gained by suitable after-treatment.

The patella should first be mobilised in the manner mentioned above.

The limitation of flexion may be overcome by the following methods:

Method 1 (Fig. 52).—In the case of the right knee, the surgeon grasps the patient's knee with the left hand which guards and sup-



FIG 58—METHOD OF MANIPULATION OF KNEE (RIGHT) TO CORRECT LIMITATION OF EXTENSION DUE TO DENSE ADHESIONS

ports the patella, while with the right hand he grasps the patient's leg in the middle or lower third. The patient's thigh is flexed upon the abdomen and the knee is gradually flexed by the exercise of steady pressure. In the case of the left knee, the position of the hands is reversed

Method 2 (Figs 56 and 57)—The patient sits or lies with the affected leg bent over the end of the couch or operating table. The surgeon seats himself (Fig. 56) or stands (Fig. 57) in such a way that the patient's foot is firmly fixed between his thighs, while with both hands he grasps the patient's knee and, in particular, protects the patella The actual flexion of the patient's knee is produced

ments of flexion and extension are not of a purely hinge-like character, as in the elbow-joint, but are accompanied by a complicated gliding movement of the tibia and the semilunar cartilages upon the condyles of the femur.

If this fact is overlooked there is a grave risk of producing a



FIG. 57—MANIPULATION OF KNEE (LEFT) TO CORRECT LIMITATION OF FLEXION DUE TO DENSE ADHESIONS—ALTERNATIVE METHOD.

subluxation of the tibia, particularly when attempting to overcome limitation of extension of the knee.

A shorter leverage is utilised, and, needless to say, the greatest care is exercised. Experience teaches the amount of force that may justifiably be exerted, but this should never be great. A skilled manipulator will gradually coax the movement back to the stiff joint. In this process there should be a complete absence of hurry and fussiness, or of undue force. When should the surgeon desist?



Fig 62—Application of Plaster

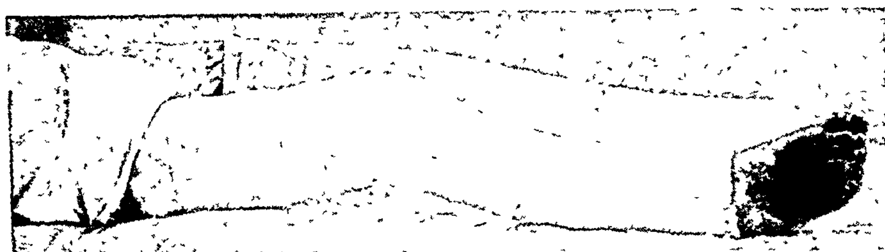


Fig 63—Completion of Plaster



Fig 64—Plaster has been Bivalved but not Finished Off



FIG 59 — CORRECTION OF FLEXION DEFORMITY OF KNEE IN RHEUMATOID TYPE OF ARTHRITIS CONDITION BEFORE MANIPULATION



FIG 60 — MANIPULATION IN PROGRESS THE ASSISTANT APPLIES TRACTION UPON THE LEG

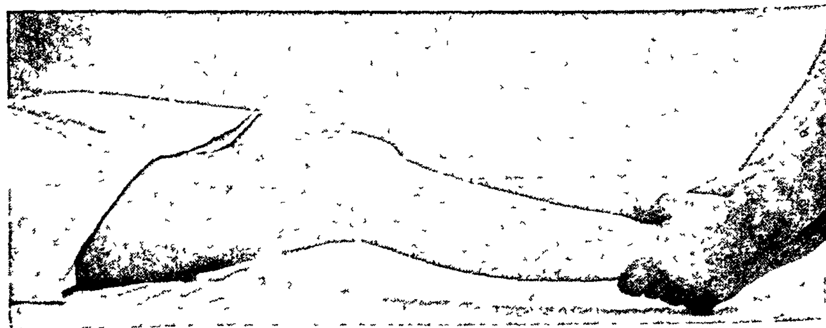


FIG 61 — CONDITION AT END OF MANIPULATION

taken that the increase in extension is not accompanied by a decrease in flexion.

When it is necessary to overcome the limitation to movement by stages, the corrected position is maintained between each manipulation in some form of adjustable splint or in a removable plaster case.

Manipulative Technique in Lesions of the Semilunar Cartilages.

The indications for manipulation in the treatment of this large group have already been discussed. It should be remembered that in the commonest type of lesion the inner side of the joint is "opened up" during a sudden rotatory movement with the knee partially flexed. The internal semilunar cartilage, having been partially torn from its attachments, is displaced towards the interior of the joint, and then, before it can return, is crushed between the inner condyles of the femur and tibia and split. In the most frequent type, the outer fractured portion, the so-called "handle of the bucket," usually lies in the intercondylar interval between the crucial ligaments and the outer border of the internal femoral condyle The inner portion lies in contact with the capsule in its usual position, but is, owing to the tearing of some of its attachments, abnormally mobile. The problem, therefore, is how to cause the outer portion which has become dislocated into the interior of the joint to retrace its steps. In other words, our aim must be to bring the two fractured portions into accurate apposition at the earliest possible moment before degenerative changes have occurred therein, and the chances of repair consequently reduced If manipulative replacement is attempted early, we are assisted by the natural elastic tendency of the displaced portion to spring back into position Replacement is in some recurrent cases simple and straightforward, but in others, and in original displacements which have remained unreduced for several days or weeks, is often a difficult manœuvre An important essential is to obtain complete muscular relaxation, and for this purpose an anæsthetic is usually desirable (see page 66) Intravenous pentothal is excellent for this purpose, and a small dose (half-gramme) may be given in the surgery or out-patient department, provided the patient can rest sufficiently before returning home. Nitrous oxide is unreliable even when combined with oxygen. The majority of the bone-setters of the past, some of whom acquired considerable fame, performed these manipulations without anæsthesia. The methods some of them adopted to abolish muscle spasm were in many cases most

by the movement of the operator's thighs aided by his hands, which assist the gliding backwards of the head of the tibia during flexion.

The limitation of extension may be overcome as follows

When limitation of extension is more marked (Figs. 58 and 60), the methods described on p. 131 are attended with risk of subluxation of the tibia, and the following method is recommended The operator grasps the head of the tibia with both hands, and while his assistant applies traction to the lower part of the leg, causes it to glide forwards around the femoral condyles in a natural manner.

Figs. 59 to 64 are photographs of the stages in rectifying flexion deformity of the rheumatoid type of arthritis of the right knee. Fig. 59 shows the degree of flexion present before the manipulative operation Fig. 60 shows the manipulation in progress, the operator is attempting with his right hand to guide the head of the tibia around the condyles of the femur, which he grasps with his left hand his assistant is maintaining traction upon the leg. Fig. 61 shows the improvement obtained at the end of the operation, extension is not complete, neither was it aimed at, as it was considered advisable to rectify the deformity in stages. Fig. 62 shows the application of plaster; a posterior slab was applied first to the back of the thigh and leg and can be seen *in situ*; the circular turns of plaster bandage are being applied. As the plaster-of-paris case is to be bivalved at the end of the operation a layer of stockinette was not used. Fig. 63 shows the completed plaster, and in Fig 64 the plaster has been bivalved.

After-Treatment.—In cases of minor adhesions the general rule of immediate re-education is followed. Where, however, the stiffness has been more marked, the immediate after-treatment depends upon whether flexion or extension was the movement previously limited. If the former, the knee is temporarily fixed in as fully flexed a position as possible, either in a hinged splint or plaster, the latter being bivalved within twenty-four hours to permit re-education. It is important to pay attention to ensure that increased flexion is not obtained at the expense of extension. For a few days the splint is reapplied at the end of each treatment. Particular attention is paid to the maintenance of the increased range obtained, and this requires perseverance, patience, and determination on the part of both patient and the person responsible for the after-treatment. When extension has been limited, the same principles of after-treatment are applicable, and the limb is fixed in extension for the same period. Here again care must be



FIG. 66.—METHOD I STAGE 2: ROTATION COMBINED WITH ABDUCTION

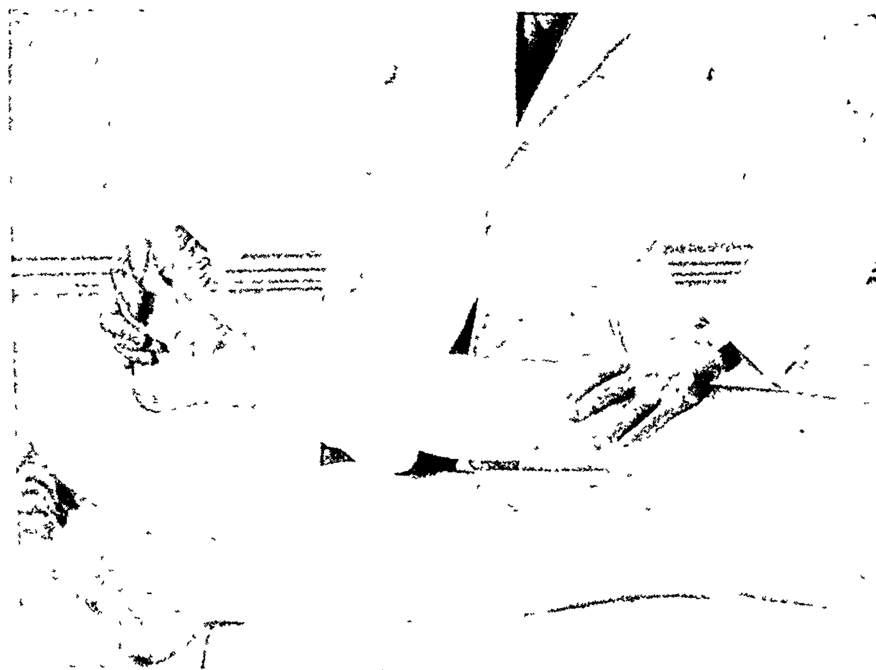


FIG 67 —METHOD I STAGE 3: EXTENSION TERMINATING IN INTERNAL ROTATION

ingenious Bone-setter Hutton used to say, "It's the twist that does it"; by a swift movement of rotation of the flexed knee he rendered the powerful flexors and extensors temporarily powerless; then, by a rapid movement of extension, induced the torn and displaced cartilage to retrace its steps. However, the replacement of an original displacement of a semilunar cartilage without an anæsthetic is nearly always an acutely painful process and one which muscular spasm may make difficult and prolonged. It is wise, therefore, to utilise the services of an anæsthetist, if available, unless the patient is unwilling. The following method usually succeeds,

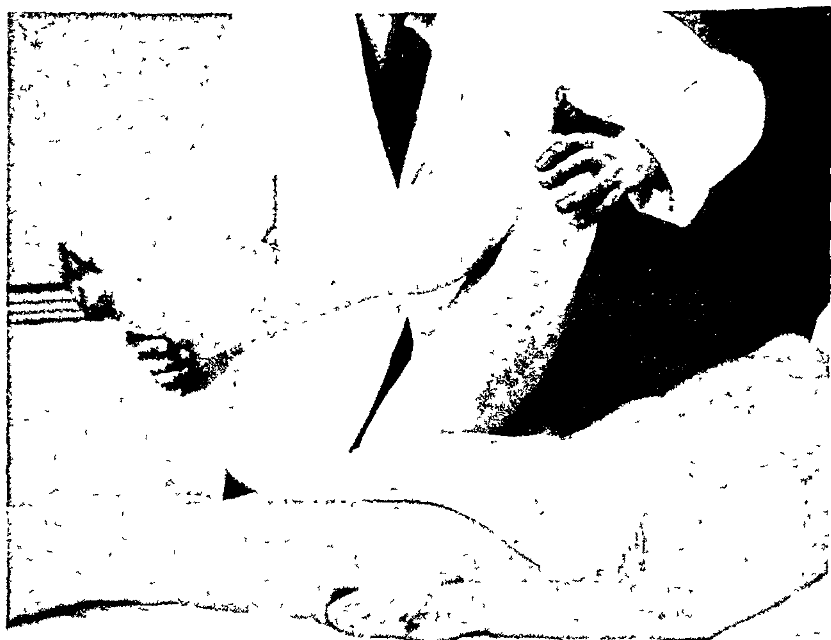


FIG. 65—MANIPULATION OF KNEE (RIGHT) FOR FRACTURE-DISLOCATION OF INTERNAL SEMILUNAR CARTILAGE METHOD 1. STAGE 1 FULL FLEXION

and is therefore recommended (Figs 65-67), displacement of the internal semilunar cartilage of the right knee being described first

Method 1—The patient lies upon his back upon a low couch or operating table In the case of the right knee, the surgeon grasps the patient's foot with his right hand and the patient's knee with his left hand He flexes fully the patient's knee, and while abducting as much as possible, thus opening up the inner side of the joint, rapidly rotates the tibia inwards and outwards. In some cases, as soon as relaxation is complete, the mere movement of full flexion

bent or the leg hangs over the lowered end of the operating table. The surgeon stands in front and grasps the upper end of the patient's leg just below the knee with both hands, the lower end of the patient's leg being gripped by the surgeon's thighs. In the case of the internal semilunar cartilage, using the thigh grip, he abducts the patient's leg, thus opening up the inner side of the joint. Next he rotates the head of the tibia both inwards and outwards by his hands, and during this movement the characteristic "snap" usually occurs which indicates the replacement of the fractured portion of the meniscus The manipulation is completed by releasing the thigh grip and making use of a strong movement of extension, including the "screw-home" movement, whereby the cartilage is forced firmly into position.

The test of reduction consists in the fact that **the patient can extend fully the knee without pain.** If full extension is restricted by only a few degrees and is painful, it is useless to deceive oneself that the cartilage is reduced. Sometimes when the practitioner has assured the patient that the cartilage has been reduced, he has been disconcerted when the patient has declared that the cartilage was still "out." The patient's feelings are often in fact a reliable indication of the success or otherwise of the manipulation.

After-Treatment.—At one time complete immobilisation in extension for a somewhat long period was advised after reduction in order to permit union to take place. A too rigid observance of rest leads, however, to two very serious complications.

(*a*) Wasting of the thigh muscles, particularly the quadriceps extensor cruris.

(*b*) Adhesions.

Furthermore, there appears to be no evidence that the earlier institution of re-educational exercises, provided those of a rotatory nature are avoided, does not assist rather than impede the processes of repair in the fractured cartilage.

Repair of a fracture of the semilunar cartilage probably only takes place in peripheral tears. It is certain that this process is extremely slow, and that complete repair is a question of months rather than weeks. To immobilise for two or three weeks is therefore futile; and to attempt immobilisation for the longer period is undesirable, and liable to inflict permanent damage upon the joint. The patient should keep the leg up and avoid weight-bearing only while the symptoms are acute. Heat and effleurage are helpful in relieving discomfort in the joint, and, in the intervals, a compression bandage over a thick layer of wool is worn and continued for four to six

causes the displaced fragment to return with an audible snap. In others, this takes place during the rotatory movements. In the majority, however, a movement of extension, accompanied by internal rotation of the tibia, is the movement which has the desired result In dealing with fracture-dislocations of the external semi-



FIG 68 —METHOD 2. MANIPULATION FOR FRACTURE-DISLOCATION OF SEMILUNAR CARTILAGE

lunar cartilage, the outer side of the joint must be opened up by adducting the leg, and the final movement of extension is performed with the leg externally rotated. In the case of the left knee, the position of the hands is reversed If these methods fail, the operator proceeds to—

Method 2 (Fig 68) —The patient sits in a chair with the knee

fasciculi separated by weaker portions of the capsule. The anterior fasciculus passes from the anterior margin of the external malleolus near its tip to the outer surface of the neck of the astragalus. The middle fasciculus passes from the apex of the external malleolus to a tubercle on the outer surface of the os calcis. The posterior fasciculus is almost horizontal, and passes inwards and slightly backwards from the pit on the inner surface of the external malleolus to the

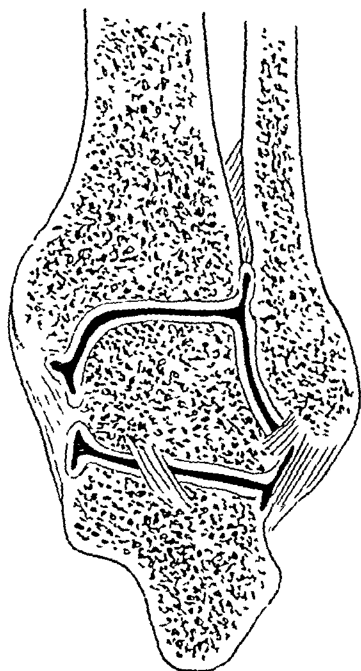


FIG. 69.—CORONAL SECTION OF ANKLE AND SUB-ASTRAGALOID JOINTS

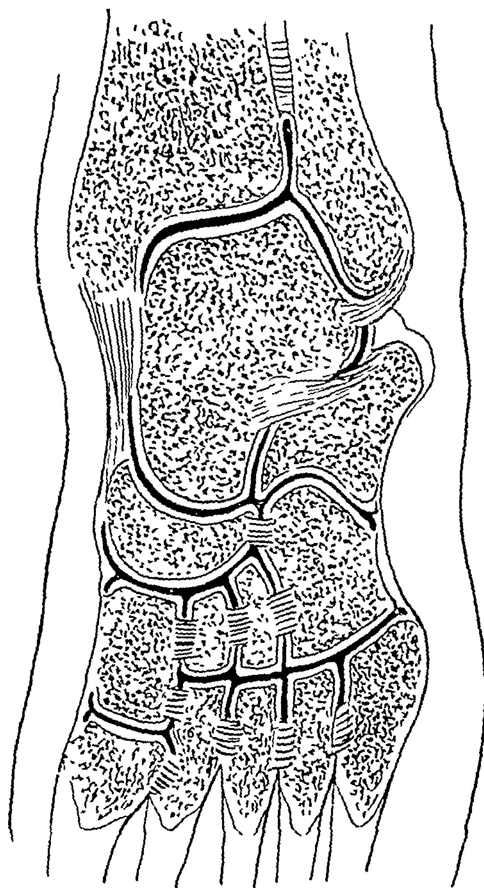


FIG. 70.—CORONAL SECTION OF FOOT AND ANKLE TO DEMONSTRATE SYNOVIAL CAVITIES.

posterior surface of the astragalus, external to the groove for the flexor longus hallucis.

Synovial Membrane.—Lines the deep surface of the capsule, and is reflected to the margins of the articular cartilage. It sends a process upwards between the lower ends of the tibia and fibula.

weeks in the average case. The compression bandage is worn until all effusion has subsided and then gradually abandoned. When gentle weight-bearing exercises are resumed, the inner side of the heel is wedged, and the patient warned not to turn the toes outward. All movement and exercises involving rotation are avoided, and active exercises against resistance commenced, supplemented in some cases by electrical stimulation of the quadriceps, as soon as the acute pain and swelling have subsided. In fact, the treatment is somewhat similar to that of sprain of a lateral ligament.

(C) THE ANKLE-JOINT.

Surgical Anatomy (Figs. 69 and 70) —The ankle is a hinge-joint in which the lower articular surface of the tibia with the outer surface of its internal malleolus and the inner surface of the external malleolus of the fibula articulate with the upper and lateral surfaces of the astragalus. The upper articular surface of the astragalus is broader in front than behind

The *Capsular Ligament* is a fibrous membrane varying in strength, which is reinforced at certain areas by accessory ligaments. It is attached above to the margins of the articular surface of the tibia, and below to the astragalus around its upper articular surface.

The *Anterior Ligament* is attached above to the anterior margin of the lower end of the tibia, and below to the upper surface of the neck of the astragalus just in front of the articular surface.

The *Posterior Ligament* is attached above to the posterior margin of the lower end of the tibia, to the inferior transverse tibio-fibular ligament, and to the pit on the inner surface of the external malleolus and below to the upper surface of the body of the astragalus behind the upper articular facet.

The *Internal Lateral* or *Deltoid Ligament* is triangular in shape, and attached above to the apex and anterior and posterior borders of the internal malleolus. The superficial fibres are attached below from before backwards into the tuberosity of the scaphoid, the inner margin of the inferior calcaneo-scaphoid ("spring") ligament, the sustentaculum tali of the os calcis, the inner surface of the astragalus, and the tubercle on its posterior surface. The deep fibres are attached above to the tip of the internal malleolus, and below to the inner surface of the astragalus.

The *External Lateral Ligament* consists of three well-marked

passes below the peroneal tubercle on the outer surface of the os calcis; each tendon is surrounded by an extension from the common synovial sheath

Posterior Aspect: Tendo Achillis.—This tendon narrows as it descends, but expands somewhat at its termination. It is inserted into the middle of the posterior surface of the os calcis. A synovial bursa separates the tendon from the upper part of the posterior surface of the os calcis.

Movements (Fig. 71).—The normal weight-bearing position of the foot is when it forms an angle of 90 degrees with the leg. In flexion or dorsiflexion (Fig. 72) the foot moves upwards at the ankle-joint and forms a more acute angle with the leg. Extension or plantar flexion (Fig. 73) is the opposite movement, in which the toes are pointed downwards and the foot forms an obtuse angle with the leg. To avoid confusion, it should be remembered that dorsiflexion at the ankle is produced not only by the tibialis anticus and peroneus tertius, but by the extensors of the toes—viz, extensor longus digitorum and extensor longus hallucis. Similarly, extension at the ankle or plantar flexion (*i.e*, pointing the toes) is produced by the gastrocnemius, soleus, tibialis posticus, peronei longus and brevis, plantaris, and the **flexors** of the toes—viz., flexor longus digitorum and flexor longus hallucis.

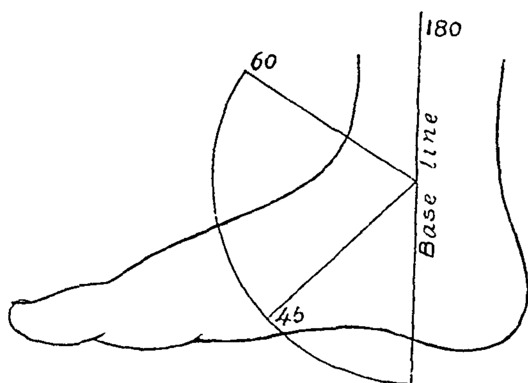


FIG 71 —RANGE OF ANKLE MOVEMENTS

To avoid confusion, it should be noted that in extreme dorsiflexion the foot forms an angle of 60 degrees with the base line, but that the foot moves through 30 degrees from the neutral position

The actual range of movement at the ankle-joint varies within considerable limits in different normal individuals, and depends largely upon the position of the knee When the knee is extended, as in the normal weight-bearing position, it is unusual for more than 15 or 20 degrees of dorsiflexion to be possible, and in some individuals this can only be obtained by slightly everting and abducting the foot. If the knee is simultaneously flexed, dorsiflexion is possible through 30 degrees Extension of the foot at the ankle-joint is usually possible through 45 or 50 degrees beyond the right angle—*i.e*, until the foot makes an angle of 135

Surgical Anatomy of the Peri-Articular Tendons of the Ankle, with their Synovial Sheaths—*Anterior Aspect.*—The anterior annular ligament, a well-defined condensation of the deep fascia, is divided into two distinct portions. The upper is a transverse band attached externally to the fibula and internally to the tibia slightly above the level of the ankle-joint. Beneath it the extensor tendons pass, the tendon of the tibialis anticus being surrounded by a separate synovial sheath. The lower portion of the anterior annular ligament is Y-shaped, and is situated over the joint interval. The narrow outer portion is attached to the outer part of the os calcis, while internally the upper divergent band is attached to the internal malleolus, and the lower band blends with the deep fascia on the inner aspect of the foot. The synovial compartments beneath this Y-shaped portion of the anterior annular ligament should be carefully noted, and are of considerable practical importance.

The innermost tendon, that of the tibialis anticus, passes through both limbs of the Y-shaped portion, and receives a sheath of synovial membrane at each spot. External to this tendon, the tendon of the extensor longus hallucis behaves in a similar fashion. Still more external, the tendons of the extensor longus digitorum and extensor brevis digitorum pass through the apex of this portion of the annular ligament surrounded by synovial sheaths.

Internal Aspect—The *internal annular ligament* bridges over the interval between the internal malleolus and the prominence of the os calcis. Septa pass between its deep surface and the bone, and separate the interval into compartments for the tendons, vessels, and nerve, which are disposed as follows from within outwards.

1. Tendon of tibialis posticus.
2. Tendon of flexor longus digitorum.
3. Posterior tibial vessels and nerve
4. Tendon of flexor longus hallucis.

Each of the tendons is covered by a synovial layer, which lines also the sheath which surrounds it.

External Aspect · The External Annular Ligament—The peronei tendons are held in place in the hollow between the external malleolus and the prominence of the os calcis by the above-mentioned ligament, and are surrounded at this spot by a common synovial sheath. Having emerged from beneath the ligament, the tendons diverge on the outer surface of the os calcis. The tendon of the peroneus brevis passes above and the tendon of the peroneus longus

or 140 degrees with the leg. Another fact to be borne in mind is that the axis of the astragalus is slightly oblique, and that dorsiflexion of the foot is associated with slight eversion and abduction, and extension or plantar flexion with slight inversion and adduction. Owing to the shape of the upper surface of the astragalus, lateral movement at the ankle-joint is only possible, and to a limited degree, during full plantar flexion.

Indications for Manipulation of the Ankle.

In the consideration of limitation of movement at the ankle-joint it is necessary, having excluded limitation due to bone, to distinguish between two different causes. Firstly, limitation primarily due to an affection of the joint, which has brought about the presence of synovial or capsular adhesions. Secondly, limitation of movement due to shortening of tendons and other peri-articular structures, or that which is primarily, and often solely, due to peri-articular adhesions in or about tendon sheaths.

Examples of stiffness due to primary affections of the joint, are adhesions following traumatic synovitis due to sprains or contusions, infective synovitis, and chronic arthritis. Sprains of the ankle very frequently involve the anterior fasciculus of the external lateral ligament, and, in chronic forms associated with adhesions, a localised area of tenderness over this fasciculus is often encountered, combined with a painful limitation of inversion of the foot. Fractures into the joint or fracture-dislocations, such as Pott's fracture, in which prolonged immobility has been practised, are also potent causes of stiffness of the ankle-joint. It should be noted that, in some of these cases, the limitation of movement is due, in part, to definite bony obstruction, when open operation combined with manipulation may be necessary In other cases, as we have seen, the stiffness is due to causes around the joint.

A good example of the latter is seen in talipes equinus or equino-varus, where a shortening of the tendo Achillis has taken place which causes limitation of dorsiflexion at the ankle-joint. In the opposite and rarer condition of talipes calcaneus there may be limitation of plantar flexion at the ankle-joint.

It should be remembered also, as in the case of the wrist, that many sprains in the region of the ankle involve the tendons, and that these may lead to limitation of movement of the ankle-joint or of other joints in its immediate neighbourhood. This limitation may be so slight that it is revealed only by the most careful examination, yet it may be sufficient to give rise to considerable disability. It is not difficult to grasp this fact, if we remember the number and



Fig 72 —Movements of Ankle Flexion or Dorsiflexion



Fig 73.—Movements of Ankle Extension or Plantar Flexion

FIG 75 —MANIPULATION OF RIGHT ANKLE DORSIFLEXION WITH KNEE FLEXED TO RELAX GASTROCNEMIUS AND SOLEUS



FIG 76.—MANIPULATION OF RIGHT ANKLE. PLANTAR FLEXION.

importance of the tendons that lie in the immediate vicinity of the joint. Adhesions may occur after a sprain of the extensor tendons on the anterior aspect of the ankle, between one of the tendons and its synovial sheath, or between the tendons and some portion of the anterior annular ligament. Similarly, such adhesions may occur on the outer or inner side of the ankle, and manifest themselves by localised pain and tenderness, and by pain accompanying movements that stretch the affected tendon or



FIG 74 —MANIPULATION OF RIGHT ANKLE DORSIFLEXION

(This manœuvre should also be carried out with the knee flexed to relax the gastrocnemius and soleus See Fig 75)

tendons. This will be clear if the surgical anatomy of this important and somewhat complicated region be remembered.

Manipulative Technique.—The patient lies upon his back upon a couch or operating table, and an anæsthetic such as gas, gas and oxygen, or pentothal is desirable except in minor cases, when local anæsthesia may suffice In the case of the right ankle, the surgeon grasps the front part of the foot with his right hand so that the palmar surface of his hand is in contact with the sole in the region of the metatarsal heads. With his left hand the surgeon grips the lower part of the leg above the malleoli. While simultaneously

Unless, however, this type of injury is seen quite early, operation is required, in chronic cases fixation with a pad or plaster being usually ineffectual

Manipulation of Ankle-Joint—Illustrative Cases.

CASE I —Captain M. fractured the lower third of the right fibula one year previously This was treated for some time as a sprained ankle After the accident he experienced pain in the ankle, with slight swelling and a tired feeling after games. More recently his ankle frequently "turned over" at golf.

On Examination —Localised tenderness over anterior part of external lateral ligament, with pain on full inversion. Slight irregularity of the external malleolus

Manipulation.—Forcible inversion associated with thumb pressure over tender area Immediate massage and exercises instituted. Satisfactory result.

CASE II —K M sustained Pott's fracture of the left ankle three months previously, and a long period of rest was ordered He complained of pain in the front of the ankle and swelling after exercise, and had undergone a long course of massage and movements

On Examination —Ankle movements, both active and passive, restricted 35 per cent

Manipulation was performed and full movements obtained, during which adhesions were heard to give way Satisfactory result

CASE III —C , aged 42, was knocked down by a waggon, which passed over both lower extremities, and he sustained, among other injuries, a lesion of the right sciatic nerve No serious attempt had been made to prevent deformity, the right foot was firmly fixed in the equino-varus position, and marked contracture of the tendo Achillis was present. A very slight degree of movement was present in the flexors and extensors of the ankle and toes, and marked wasting of the leg muscles existed with sensory changes

Operation —A subcutaneous tenotomy of the tendo Achillis was performed in two places, and by means of a Thomas's wrench the deformity was overcome with considerable difficulty, owing to the stiffness of the ankle and mid-tarsal joints The corrected position was maintained at first by a splint, although massage and electrical treatment were continued In a few weeks he was able to walk in a special boot furnished with a toe-raising spring, and the deformity having been corrected the best conditions were present for gradual recovery of function. The man has since resumed his previous occupation as a waggoner.

It should be noted that, whenever possible, it is more advantageous to stretch the tendo Achillis gradually by exercises or more rapidly by manipulation than to perform tenotomy or tendon lengthening

separating the joint surfaces by traction he presses firmly upwards with his right hand and forces the foot into dorsiflexion (Fig. 74) This manœuvre is valuable for stretching minor contractures of the tendo Achillis, such as occur in women who wear high-heeled shoes. This movement should also be carried out with the knee flexed in order to relax the gastrocnemius and soleus (Fig. 75). In performing plantar flexion (Fig. 76), the surgeon alters the position of his right hand so that its palmar surface is applied to the dorsal aspect of the patient's foot and the foot is forced into plantar flexion. This movement is carried out with the knee fully extended In the case of the left ankle, the position of the surgeon's hands is reversed When adhesions exist in the extensor sheaths, firm thumb pressure is exerted upon any tender area, and a rapid movement of plantar flexion performed with the surgeon's other hand. In the case of adhesions involving the flexor tendons behind the internal malleolus, similar pressure is adopted, but the foot is forcibly dorsiflexed and everted, and in the case of adhesions involving the peronei tendons the foot is dorsiflexed and simultaneously inverted In the common type of adhesions in the anterior fasciculus of the external lateral ligament following sprain, a sharp movement of inversion of the plantar flexed foot (Figs. 43 and 44) is performed. When dorsiflexion is limited by contracture of the tendo Achillis, much can often be done by one or more manipulations, if the case prove not amenable to other methods. In obstinate cases, manipulation must be combined with open or subcutaneous tenotomy of the tendon.

Dislocation of Peroneal Tendons.

This is a comparatively rare accident, but one which must always be borne in mind in injuries in the vicinity of the ankle-joint. One or both of the peronei tendons may slip forwards on to the outer surface of the external malleolus owing to rupture of the external annular ligament. It should be immediately rectified by plantar flexion and eversion of the foot combined with digital replacement. The tendon must be retained in its proper position by firm pressure by means of a felt pad covered with strapping or by a removable plaster cast. The foot is kept thus in the everted position for at least four weeks. Gentle exercise may be permitted, but all movements which stretch the damaged annular ligament must be avoided until repair has taken place, as otherwise the condition is apt to become recurrent.

qualified chiropodist in attendance, and regular inspection of the feet should be a routine in every military establishment.

Formerly painful feet were relegated to a miscellaneous scrap-heap of "minor" disabilities which, although very frequently



FIG 77—MOVEMENTS OF FOOT INVERSION COMBINED WITH ADDUCTION (SUPINATION).

encountered, were not considered worthy of special study and research. Hence multitudes of sufferers, being dissatisfied with the orthodox but ineffectual arch-supports and ugly "surgical" boots, were driven to bone-setters, who by their manipulations often gave great relief.



FIG 78—MOVEMENTS OF FOOT. EVERSION COMBINED WITH ABDUCTION (PRONATION)

Many—indeed, probably the majority—of the disabilities of the foot are due to, or aggravated by, unsuitable footwear. The invention of a shoe which is anatomically correct and which also satisfies the æsthetic sense appears hitherto to have presented insuperable diffi-

(D) THE JOINTS OF THE FOOT.

Of these joints, the mid-tarsal, which plays an important part in the longitudinal arch of the foot, must claim principal consideration. The mid-tarsal joint is formed by the articulation of the astragalus and os calcis behind with the scaphoid and cuboid in front. At this joint occur the movements of inversion and eversion, adduction and abduction, and combinations of these movements known as supination and pronation.

Inversion.—In this movement, the whole foot rotates about an antero-posterior axis, so that the sole of the foot is directed inwards and downwards.

Eversion is the opposite and less extensive movement, in which the sole is directed outwards and downwards.

The movements occur principally at the mid-tarsal joint, but also at the joint between the astragalus and os calcis (subastragaloid).

Abduction is the movement outwards of the front part of the foot at the mid-tarsal joint.

Adduction is the movement inwards of the front part of the foot at the same joint.

Supination (Fig. 77) is a combination of inversion and adduction.

Pronation (Fig. 78) is a combination of eversion and abduction.

The last two movements of the foot are also applied to positions, especially in the weight-bearing foot In standing, for example, the weight-bearing foot tends to assume the pronated position.

Chronic Foot Strain ("Flat Foot").

The amount of suffering caused by disabilities of the feet is incalculable, and it is gratifying to observe that this important subject is at last receiving the attention that it deserves. War conditions, with the change from sedentary occupations to forms of national service involving much standing or marching, have been responsible for great numbers of disabilities of the feet, with consequent interference with maximum output from the factory and of military efficiency. In the case of factory workers, much of the disability is also attributable to standing for long periods in unsuitable footwear. In all cases of sudden change from a sedentary life to one of great activity, a short preliminary period devoted to getting the feet into condition, combined with elementary instruction on taking care of the feet, is of great value in preventing subsequent disability. Every large factory should have its foot clinic with a



FIG 79 —MANIPULATION OF MID-TARSAL JOINT INVERSION AND ADDUCTION.

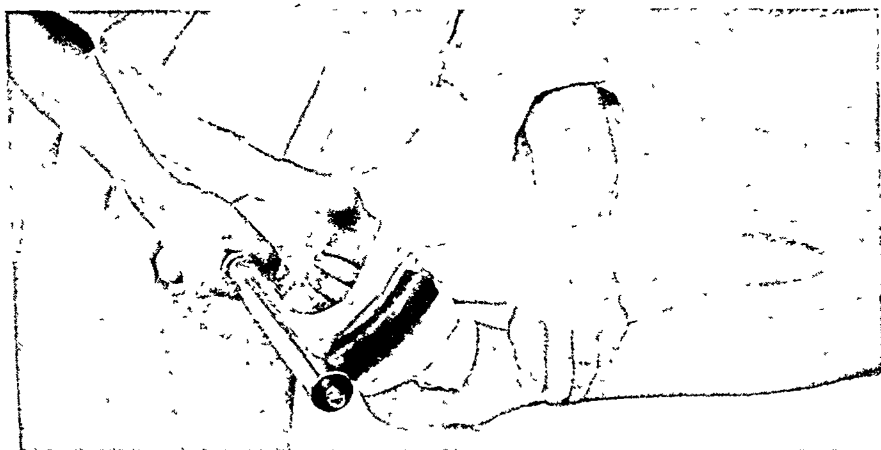


FIG 80 —USE OF THOMAS'S WRENCH IN RESTORING ADDUCTION AND INVERSION AT MID-TARSAL JOINT

culties, and it is hoped that orthopædic surgeons and shoemakers will co-operate to remedy this unfortunate state of affairs.* This might prove to be a valuable feature of campaigns for national fitness.

A detailed discussion of this important problem is beyond the scope of this work, but a short account will be given of the treatment of chronic foot strain by manipulation, as this probably constitutes one of the most valuable advances in orthopædic surgery of recent years

Chronic Foot Strain involving Longitudinal Arch.

The longitudinal arch, although not a rigid structure, is a definite architectural feature of the normal foot, and manipulation which aims at breaking down or obliterating this arch, as is sometimes advised, is based upon unsound principles

The term " flat foot " is unfortunate because (*a*) some of the most severe cases of foot strain are associated with a well-formed longitudinal arch, (*b*) the height of the arch is a variable factor, and many individuals have flat feet without any symptoms of foot strain A flat foot is pathological only when the patient is unable to raise the arch by voluntary effort or when it is painful

In foot strain of the longitudinal arch there is, at first, a failure of the tone of the muscles by which the arch is normally supported. This causes strain to fall upon ligaments such as the inferior calcaneo-scaphoid, with consequent pain in standing or walking and tenderness on deep palpation over this ligament. Owing to the loss of muscle tone, the longitudinal arch, of which the astragalus forms the key-stone, sinks and the foot becomes everted and pronated at the mid-tarsal joint

At first the patient is able to restore the arch, voluntarily correct the deformity, and invert and evert the affected foot by muscular effort. In the later and neglected stages this is impossible, because the muscles are worn out and the deformity has become fixed by scar-tissue and by secondary shortening of peri-articular tendons and other structures. In the most neglected cases, changes occur in the shape of the bones due to secondary osteo-arthritis

The orthodox treatment for many years has been merely palliative

* The report of the Government-sponsored Working Party of the boot and shoe industry published on August, 29, 1946, states that " well-fitting shoes are vital to the health of the nation ", it is wisely suggested that a " hallmark of quality " should be available when footwear complies with certain minimum requirements In this way shoddy footwear would gradually be eliminated.

with the left hand and the front part of the foot with the right, applies traction with the foot in plantar flexion and then forcibly inverts and adducts the foot (Fig. 79), using in obstinate cases as a fulcrum a wedge-shaped block covered with leather upon which the middle of the inner border of the foot rests. An alternative method of applying inversion and adduction of the foot is shown in Fig. 81. Using the right foot again as the illustration, the surgeon grasps the front part of the foot with his right hand and the lower part of the leg with his left, forcibly inverts and adducts the foot, and accompanies this with a body swing, thus exercising more force than in the first method. The surgeon next forcibly everts the foot at the mid-tarsal joint, applying traction as before in plantar flexion (Figs. 82 and 83). The photographs demonstrate the technique. Fig. 83 shows a method of using both hands by which an application of greater force is possible in marked cases. The use of Thomas's wrench in cases of obstinate stiffness of the mid-tarsal and ankle joints constitutes a valuable aid owing to the powerful leverage obtainable (Fig. 80). Needless to say, this instrument must be used with great care, and the force employed must be steady and continuous and never spasmodic. In more marked types, a series of manipulations is advisable, and this is certainly to be preferred to the use of considerable force at a single manipulation.

The restoration of the power of inversion is more important than that of eversion.

In deformities of the feet occurring in infants and young persons, temporary fixation in plaster after manipulative correction is necessary, owing to the great difficulty of proper control and after-treatment.

Such temporary fixation in plaster in the corrected position is also often indicated in some of the more marked deformities of the feet occurring in arthritis.

Having restored the mobility of the mid-tarsal joint, our guiding principle in after-treatment must be to develop by appropriate exercises the muscles which control the arch of the foot, weakness of which muscles is an important factor in the ætiology of the condition. The principle of weight deflection to the outer side of the foot must simultaneously be observed, and this can be achieved by raising the inner side of the heel of the shoe on the affected side or sides. It is now probably clear why complete immobilisation in plaster after correction, unless as a purely temporary measure, so often fails. The consequent muscular wasting prevents that building-up of muscular power which is one of the most essential factors in the treatment of this common and painful condition.

—viz., to support the arch crippled thus by adhesions by some form of "arch-support," which, by preventing stretching of the adhesions, may give a certain amount of relief, but is often uncomfortable and inefficient. The metallic arch-supports which are advertised so extensively are particularly bad, because their pressure causes wasting of the intrinsic muscles of the sole. The restoration by manipulation of the full movements of the foot, thereby breaking down the painful adhesions, is a greatly preferable method of treat-



FIG 81—MANIPULATION OF MID-TARSAL JOINT INVERSION AND ADDUCTION (SECOND METHOD)

ment, and has, in fact, revolutionised the treatment of this form of foot strain. The manipulation must be followed by re-educational exercises to strengthen the weakened muscles and by the avoidance of incorrect footwear.

Manipulative Technique.—The patient lies upon a couch either in the supine or lateral position. The knee is flexed, and the surgeon, in the case of the right foot, grasping the leg just above the ankle

If temporary fixation in plaster in the corrected position is practised the plaster should be bivalved early, so that exercises can be begun early; the plaster case being reapplied at the end of each session.

Spasmodic Flat Foot.

This condition is by no means uncommon and no better description of it has ever been given than that by Sir Robert Jones: "A young man of eighteen limps with a springless gait into the out-patient room. He walks with feet practically rigid and with toes pointing out. They are both everted, and the inner border over the region of the scaphoid appears thickened and even angular. Both the character of the walk and the appearance of the feet might lead to the diagnosis that osseous changes were advanced. . . . If he is asked to invert his foot he cannot do so, and when he attempts it the peronei become rigid . . . There is pain on pressure over the deltoid ligament, over the scaphoid and over the tip of the external malleolus, and tenderness over the peronei. If the surgeon gently attempts to invert the ankle much pain is experienced and the peronei immediately place themselves on guard and strongly resist his efforts. Now while he has firm hold on the foot, let him engage the patient in conversation—then at the psychological moment while the peronei are quiescent, very suddenly and very forcibly let the foot be inverted and held there It is a very painful movement, but the character and contour of the foot are completely changed. It is no longer rigid, osseous changes are obviously absent, and the general appearance of the foot is almost normal. The moment the surgeon releases his hold, the old rigidity and deformity return."*

The cause of this intense peroneal spasm is obscure It will be remembered that the two principal tendons that support the longitudinal arch are the tibialis posticus and peroneus longus The latter tendon forms a sling beneath the summit of the arch It is possible that the tibialis posticus having given up the struggle, the peroneus longus is making a gallant but unco-ordinated and spasmodic attempt to sustain the arch.

For the treatment of this condition manipulation under anæsthesia is first performed. The foot is fully inverted and fixed in this position in plaster, which is worn for at least three weeks. When the plaster is removed the patient is permitted to take gentle exercise wearing an outside leg iron with a valgus T-strap, and the inner

* Sir Robert Jones, "Notes on Military Orthopædics," Cassell and Co , 1918

FIG 82 —MANIPULATION OF MID-TARSAL JOINT ABDUCTION AND EVERSION



FIG 83 —MANIPULATION OF MID-TARSAL JOINT
The surgeon uses both hands to increase abduction and eversion.

of the sole, so that the anterior part of the foot is forced into the front of the shoe, which, as we have seen, is unfitted to receive it. Normally, the head of the first metatarsal plays a most important part in walking, but in a shoe having the above characteristics it is unable to function properly. The heads of the middle metatarsal bones are forced downwards and compelled to do the work of the first metatarsal and, through splaying of the metatarsal heads, the fore foot becomes broader and there is often associated hallux valgus. Such a state of affairs gives rise to a whole series of painful conditions affecting the front part of the foot, including that known as metatarsalgia



FIG 85 —MANIPULATION OF SAME CASE AS SHOWN IN FIG 84

In the fully developed condition, the heads of the middle metatarsal bones protrude into the sole, there is acute pain on walking which may be felt also in the calf; tenderness can be elicited beneath the head of one or other of the middle metatarsals, where an acutely tender callosity may exist; and there is secondary clawing of the toes with painful limitation of active and passive movement at the metatarso-phalangeal joints. This secondary clawing of the toes is due to weakness of the interossei and lumbricals, with uncontrolled action of the long flexors and extensors of the toes.

There can be no doubt that except in the earliest cases the heads of the metatarsal bones are fixed in the abnormal position by

side of the heel on the affected side is reinforced by a $\frac{1}{4}$-inch wedge.

Relapse, unfortunately, is apt to occur in severe types, and in this eventuality the operation is repeated and, in addition, $\frac{3}{4}$-inch of each peroneus tendon is removed just above the external malleolus. Simple tenotomy of the peronei has not proved sufficient to prevent recurrence of the deformity.

Chronic Anterior Foot Strain.

This form of foot strain is frequently encountered, particularly in women It may be present alone, but is frequently combined with

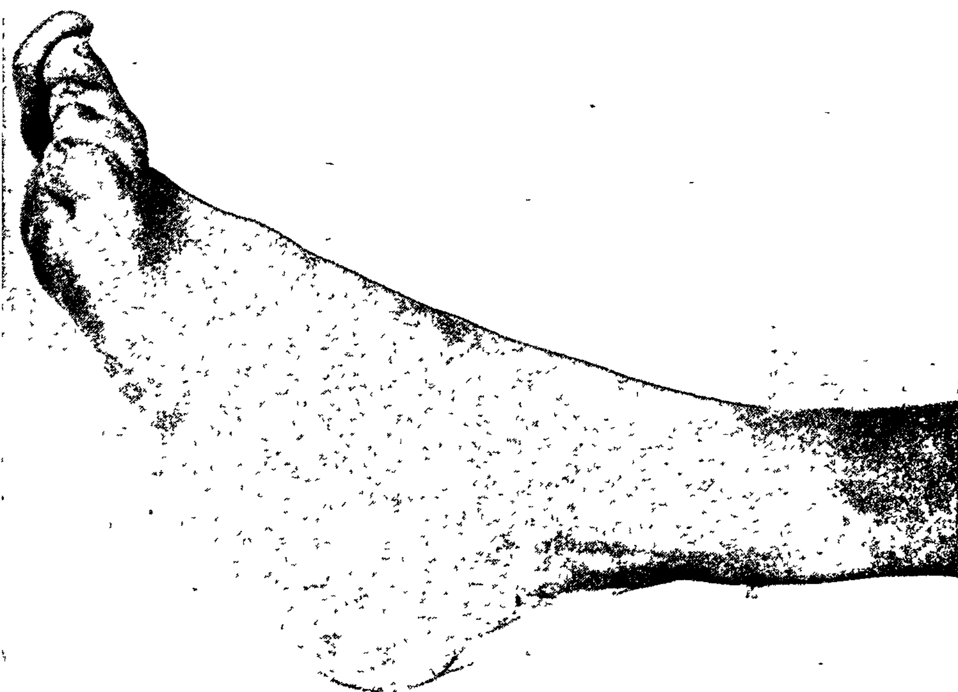


FIG. 84—ANTERIOR FOOT STRAIN, WITH SECONDARY CLAWING OF TOES

loss of the longitudinal arch and with a contracted tendo Achillis It is usually due to the wearing of incorrect shoes, the type of faulty shoe mainly responsible being the typical "fashion shoe" This is too short, has a high and narrow heel, a pointed toe too centrally placed, so that the inner border of the shoe curves outwards, and a sole which is concave from side to side anteriorly and from before backwards In such a shoe, the foot slides down the inclined plane

of the fourth metatarsal bone The term anterior metatarsalgia, suggested by Poulosson of Lyons in 1889, is now used as an omnibus term to designate both the general anterior foot strain described above, Morton's disease, and other conditions causing pain in the fore foot. The characteristic pain in Morton's disease is acute and stabbing and felt in the fourth metatarso-phalangeal joint, although occasionally in the third. Sometimes the head of the fourth metatarsal projects into the sole and there may be a corn at this site, often, however, there is no obvious flattening of the fore foot. No matter where the patient is during an attack, he must at all costs remove the shoe and manipulate the foot.

He flexes and extends the toes and squeezes them in a way which restores the arch. This instinctive behaviour should surely give us a lead. The manœuvre usually relieves the pain and is often accompanied by a distinct click, as if a subluxation of the proximal phalanx of the fourth toe had been reduced. Morton in his original paper considered that the condition was due to lateral compression of a digital nerve between the heads of the fourth and fifth metatarsal bones. Sir Robert Jones and A. H. Tubby (*Annals of Surgery*, September, 1898), by examination of frozen sections of feet, came to the conclusion that the pain was due to downwards pressure by the head of the fourth metatarsal upon a communicating branch between the external and internal plantar nerves, and they pointed out that lateral compression of the metatarsals usually relieves the pain. In most cases, I have noted a painful limitation of full flexion of the metatarso-phalangeal joint of the fourth toe with tenderness beneath the head of the fourth metatarsal. This may be noted also between the attacks. It is probable that the acute attacks are due to a partial subluxation superimposed upon adhesions in the affected metatarso-phalangeal joint. These adhesions are due to a synovitis which has arisen usually from wearing shoes which cause a faulty distribution of the body weight in walking, so that the main take-off point is at the outer metatarsal heads instead of the great toe as Nature intended.

Manipulation of the affected metatarso-phalangeal joint with particular attention to full flexion, while simultaneously maintaining strong traction, usually cures the condition, provided proper shoes are worn afterwards which allow the great toe to perform its normal functions. The cramped and atrophied musculature of the foot must also be rectified by re-educational exercises In cases which do not respond to manipulation and suitable after-treatment it may be necessary to adopt Morton's treatment—viz., removal of the head of the affected metatarsal bone.

adhesions; the painful limitation of flexion at the metatarso-phalangeal and of extension at the proximal interphalangeal joints is clearly due not only to the presence of adhesions in these joints, but to the secondary shortening of the flexor and extensor tendons Manipulation of the anterior part of the foot is therefore strongly indicated if the condition is not too advanced. Experience teaches that such a method of treatment is overwhelmingly superior to such palliative methods as massage and other forms of physical treatment, and the wearing of metatarsal pads inside the shoes

When marked shortening of the tendons has occurred, tenotomy may be necessary in addition to manipulation, but it is surprising how seldom tenotomy is necessary (Figs. 86 and 87).

Manipulative Technique.—The operator grips the toes of the affected foot with one hand, the other hand gripping the patient's instep (Fig. 85). While simultaneously applying traction, forcible flexion of all the toes at the metatarso-phalangeal joints is then carried out, followed by flexion of each toe separately. The interphalangeal joints are then straightened. Next the heads of adjacent metatarsal bones are moved forwards and backwards, and by firm pressure in the sole beneath the central metatarsal heads, an attempt is made to restore their normal positions. If the deformity is marked, it is advisable to fix the toes in full flexion over a pad of wool beneath the anterior arch for twenty-four to forty-eight hours by means of strapping, or a moulded plaster-of-paris cast which may be worn for several days in the intervals of treatment At the end of this period, or almost immediately in slighter cases, the physiotherapist commences re-educational exercises, paying particular attention to flexion of the toes. A concealed metatarsal bar should also be worn in the sole of the shoe at the level of the necks of the metatarsals to support temporarily the metatarsal arch.

It is important to bear in mind that cases of combined foot strain are frequently encountered in which both longitudinal and transverse arches are involved In such cases a combination of the methods described above is necessary—*i e.*, both arches are manipulated.

Morton's Disease or Metatarsal Neuralgia.

The condition of anterior foot strain already described involves depression of all the intermediate metatarsal heads.

In August, 1876, appeared a paper by T. G. Morton in the *American Journal of Medical Science* which described a condition in which spasmodic attacks of acute pain occur in the region of the head

whether of a rheumatic nature or due to some specific infection. In these cases also, manipulation may be of value, provided the acuter manifestations have subsided, but the results are not as a rule so satisfactory as in simple foot strain. It must be remembered that, in the rheumatoid cases, the bones of the foot are atrophic and excessive force may cause fractures.

Manipulation of the Great Toe in Hallux Valgus and Rigidus.

A condition of arthritis of the metatarso-phalangeal joint of the great toe is frequently encountered It is in most cases a form of traumatic osteo-arthritis, due to the wearing of ill-fitting boots and



FIG 88 —MANIPULATION OF METATARSO-PHALANGEAL JOINT OF GREAT TOE

shoes. There is a type of long, narrow foot which is not catered for by the "ready-made" boot or shoe, and which is particularly prone to develop a form of traumatic osteo-arthritis of this joint, because the toes are continually being crowded into the front part of the shoe and subjected to constant minor traumata It is apt to give rise to a painful limitation of dorsiflexion of the great toe of the affected foot (hallux rigidus) In another type of case, the great toe is deflected outwards at the metatarso-phalangeal joint (hallux valgus), and this deformity may also be associated with painful limitation of movement at the joint. In the later stages of both of these types, the limitation of movement is due to osteophytic formation, but, in the early stages, this is not the case, and an attempt to restore movement should always be made by manipulation if ordinary measures of

In the cases in which a neuroma of a digital nerve exists, manipulation is unlikely to be completely successful and operation will be required.

Foot Strain associated with Arthritic Changes.

In many neglected cases of chronic foot strain, such as have been described above, osteo-arthritic changes eventually supervene.



FIG 86 —CONDITION OF TOES AT END OF MANIPULATION SHOWN IN FIG 85

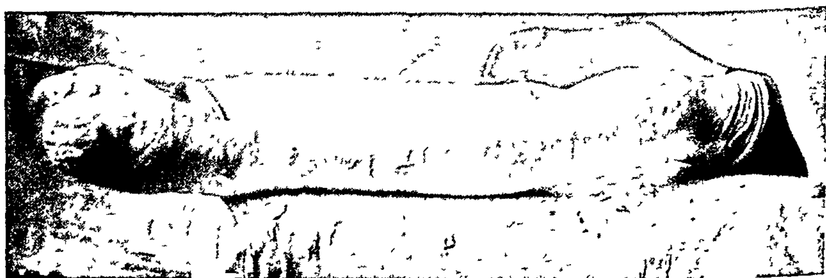


FIG 87 —THE CLAWING OF THE TOES HAVING BEEN CORRECTED, THE IMPROVED POSITION IS MAINTAINED BY PLASTER OF PARIS

Except when the changes are advanced, experience teaches that manipulative treatment on similar lines is often of value, but it is obvious that a guarded prognosis is necessary. Similar deformities of the feet are frequently seen in arthritis of the rheumatoid type,

well and without pain when she left the nursing home a fortnight later. Her further progress has been satisfactory.

CASE II.—Mrs T. had an attack of "fever" in India associated with "pains all over," which disappeared except in the right foot, which became swollen and stiff. A certain amount of improvement followed a course of vaccines, a culture being obtained from the root of an infected tooth.

On Examination.—Considerable limitation of inversion of the right foot, with tenderness over the inner aspect of the mid-tarsal joint.

Manipulation was performed, the foot being inverted and adducted at the mid-tarsal joint over a wedge, and an appreciable increase of movement obtained. No retentive apparatus was applied, but evaporating lotion was used for twenty-four hours and immediate massage begun. At the end of this period, active and passive movements were permitted, and shoes raised upon the inner sides of the soles and heels ordered. By perseverance the patient consolidated the ground gained by the manipulation, and was able, ere long, to walk without pain.

Manipulation of Metatarso-Phalangeal Joint of Great Toe—Illustrative Case.

Mrs. B. ten years ago had severe attacks of pain and inflammation in the metatarso-phalangeal joints of the great toes. This remained quiescent for some years, but latterly had been very troublesome.

On Examination.—Marked limitation of dorsiflexion of both great toes at metatarso-phalangeal joints, with a certain amount of bony thickening. The latter, however, was not the actual cause of the limitation of movement.

Manipulation was performed, a marked increase of range obtained, and immediate active and passive movements instituted, preceded by radiant heat. The improvement was maintained, and the patient was able to take up classical dancing.

She wrote two years later: "Since the manipulation my feet have never pained me, and I walk like a normal individual."

physical treatment prove to be of no avail. If, afterwards, proper boots and shoes are ordered, and the joint put through its full range of movement daily, limitation by osteophytes can often be prevented.

In performing manipulation at the metatarso-phalangeal joint, the surgeon should remember to apply traction before flexing, extending and abducting (Fig. 88).

Manipulation of Mid-Tarsal Joint—Illustrative Case.

CASE I.—Mrs E. complained of pain in the left ankle and foot, particularly on walking, and also present at night, interfering with sleep While on A.R P. duty three years ago she slipped on a baulk of timber and landed on the side of the foot "with the ankle turned completely over." First aid in the shape of a cold-water bandage was applied Next day the injury was X-rayed and a chip-like fracture of the anterior end of os calcis revealed Foot and leg from toes to just below knee were put in a walking plaster with wooden heel attached This was removed after eight weeks and another lighter plaster applied from toes to just above ankle This was removed after four weeks and massage and exercises commenced and continued for three weeks She was then discharged from hospital and told to use foot in normal way Foot and ankle remained very stiff and painful with a constant dull ache alternating with shooting pains Was limping badly. Six months later sprained ankle again and Elastoplast bandages applied Pain now began to get steadily worse and often kept her awake at night· movement became more and more restricted. Saw specialist and was now ordered a course of short-wave diathermy, massage and exercises. Had this every day for two months, the range of movements was improved, but she was still in constant pain. Given injection "between bones in the ankle on outer side of foot," but still no improvement. Ordered a course of ionisation, which she had on alternate days with short-wave diathermy for another month, pain became worse. Visiting consultant examined her and decided that no further treatment was indicated

On examination shortly afterwards, painful limitation of all movements of left ankle and mid-tarsal joint were noted and particularly inversion Slight puffiness of the ankle anteriorly and over the dorsum of the foot in the region of the mid-tarsal joint. Tenderness around anterior and lateral aspects of ankle and over mid-tarsal joint. X-ray showed nothing abnormal except the chip-like fracture of the anterior end of the os calcis mentioned above The ankle and mid-tarsal joints were manipulated under an anæsthetic on June 13, 1946. A satisfactory increase of all movements hitherto restricted was obtained without much difficulty

The patient stated that the night after the manipulation she was free from pain for the first time for three years. Re-educational exercises were commenced at once and the patient rapidly improved and was walking

border of the lesser tuberosity. The lowest gleno-humeral ligament runs from the lower part of the glenoid to the under part of the anatomical neck of the humerus

Synovial Membrane.—This covers the glenoid ligament, and is then reflected on to the capsule, the deep surface of which it clothes. When the arm hangs by the side, a well-marked pouch of synovial

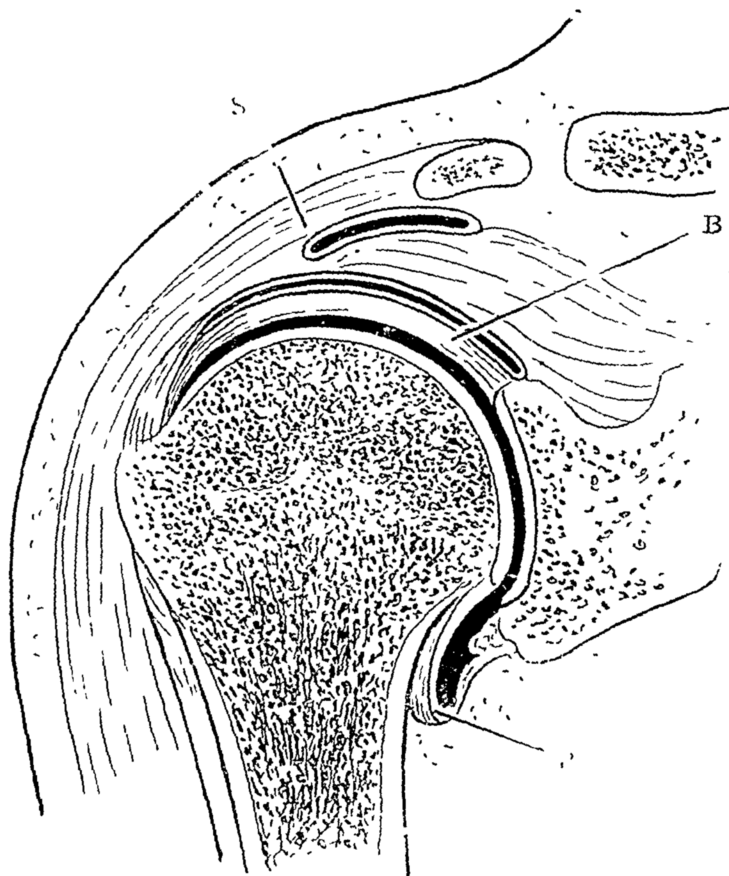


FIG 89—CORONAL SECTION THROUGH SHOULDER-JOINT

B Intra-articular portion of long tendon of biceps
P Capsular pocket, which is obliterated during abduction.
S Bursa beneath acromion process and deltoid

membrane exists below (Fig. 89). The opposed layers of this pouch are very liable in certain inflammatory conditions to become adherent, owing to organisation of plastic lymph, and painful limitation of abduction ensues. The membrane is reflected from the capsule on to the anatomical neck of the humerus above and on either side, and on to the surgical neck below and internally, whence it runs to the edge of the articular cartilage. The long tendon of the

CHAPTER VII

MANIPULATIVE TREATMENT : THE UPPER EXTREMITY

(A) THE SHOULDER JOINT

Surgical Anatomy (Fig. 89)—In this ball-and-socket joint, the head of the humerus articulates with the shallow and somewhat pear-shaped glenoid cavity of the scapula, which is deepened slightly by the glenoid ligament, formed of dense fibro-cartilaginous tissue. The articular capsule is extremely lax, and is attached proximally to the margin of the glenoid cavity and its ligament, and distally to the anatomical neck of the humerus above, and below to the surgical neck half an inch from the head With the arm hanging by the side, a well-marked pocketing of the capsule occurs below and on the inner side, which becomes obliterated during abduction. Two, and sometimes three, gaps are present in the capsule, through which bursal protrusions of the synovial membrane occur. The first permits the long tendon of the biceps, surrounded by a bursal sheath, to emerge from its origin within the joint to commence its extracapsular course The second, on the anterior aspect, allows the synovial cavity to communicate with the bursa beneath the subscapularis The third, when present, communicates with the bursa beneath the infraspinatus The capsule is strengthened by the tendons of the supraspinatus, infraspinatus, and subscapularis, which are partly inserted into it, and is weakest below, at which site dislocation usually occurs

Accessory Ligaments.—The coraco-humeral ligament strengthens the upper part of the capsule, and stretches from the outer border of the coracoid process to the anatomical neck in the region of the great tuberosity. The gleno-humeral bands are three in number—superior, middle, and inferior. They are ill-marked bands which stretch between the anterior border of the glenoid cavity and the anatomical neck of the humerus, and lie between the capsule and the synovial membrane They are best demonstrated by removing the posterior part of the capsule and the head of the humerus, and looking into the joint from behind The superior gleno-humeral ligament is fixed above to the apex of the glenoid cavity, close to the root of the coracoid process, and passes downwards to the inner side of the biceps tendon to be attached to a small depression above the lesser tuberosity of the humerus The middle gleno-humeral ligament reaches from the anterior margin of the glenoid cavity along the lower border of the subscapularis tendon to the lower

Depression of the shoulder, which is checked by the interarticular disc and the interclavicular ligament.

Movement forwards and backwards of the shoulder, during which the clavicle and disc move on the sternum.

Circumduction is a combination of these movements.

Shoulder Movements (Fig. 90).—As the scapula takes part in most of these movements, the determination of the true range at the shoulder-joint itself must be difficult, variable, and liable to inaccuracy. Cathcart (*Journal of Anatomy and Physiology*, 1884, p. 18) and Lockhart (*Journal of Anatomy*, 1930, vol. xiv, p. 238) have shown that the humerus moves on the scapula throughout the

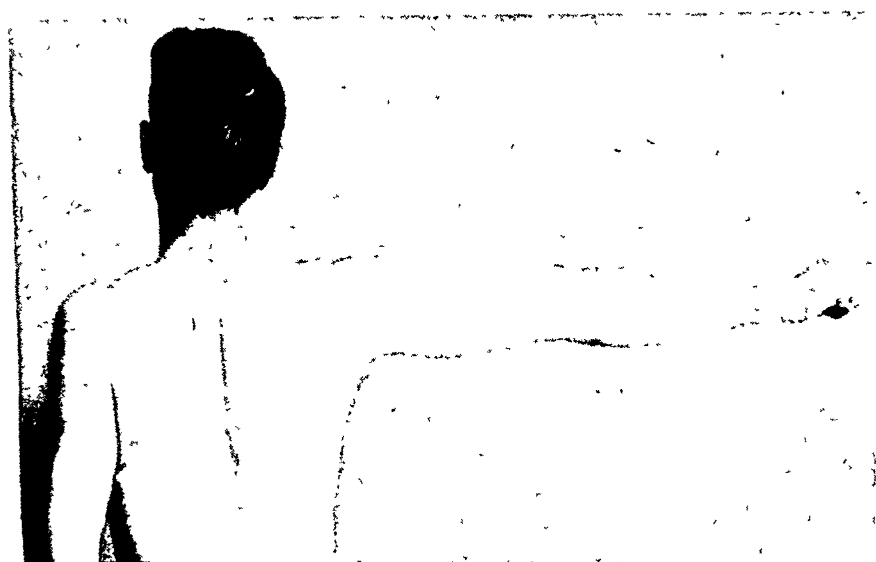


FIG 91—MOVEMENTS OF SHOULDER ABDUCTION (POSTERIOR VIEW)
The inferior angle of the scapula retains its normal position

whole range of abduction and flexion and not only in the first 90 degrees of these movements. Modern cinematography has shown, moreover, that there is some scapular movement as a preliminary movement in abduction

Flexion (Fig. 90), or movement forwards and upwards in the antero-posterior plane, takes place as far as the horizontal principally at the shoulder-joint, but in carrying the arm upwards beyond this point to the vertical position (forward elevation), the scapula moves upwards upon the chest wall. The complete range of flexion is, therefore, through an arc of 180 degrees.

Extension (Fig 90), or movement backwards in the antero-

biceps, which passes through the joint, is surrounded by a tube of synovial membrane, and is therefore extrasynovial, but intracapsular. The bursal protrusions from the general synovial cavity have already been noted.

In testing the movements of the shoulder-joint itself, it is important not to confuse the true shoulder movements with the movements that take place at the sterno-clavicular and acromio-clavicular joints. For this purpose, the scapula should be fixed.

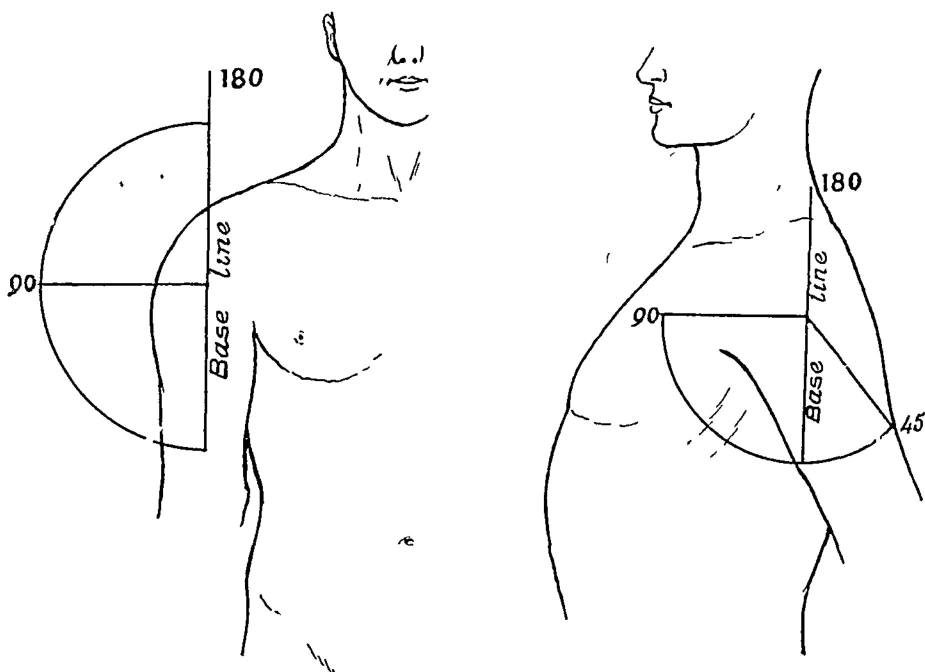


FIG 90 —DIAGRAMMATIC REPRESENTATION OF RANGE OF SHOULDER MOVEMENT

Before discussing the shoulder movements proper, a short description will be given of these scapular movements

Scapular Movements —The scapula follows the clavicle in its movements, but a certain amount of gliding takes place at the acromio-clavicular joint, which permits the scapula to remain in contact with the chest wall, and preserves the normal relationships of the glenoid cavity and the head of the humerus The following scapular movements occur.

Elevation of the shoulder, during which the sternal end of the clavicle moves on its articular disc This movement is checked by the costo-clavicular ligament.

right angle. In rupture and other forms of injury of the supraspinatus tendon the patient is unable to carry out the first 20 degrees of abduction, but if he is assisted over this stage, he is able to complete the movement by deltoid action * The arm having reached an angle of 90 degrees in the frontal plane, the lower part of the capsule becomes taut, the great tuberosity of the humerus impinges against the acromion process and coraco-acromial ligament, and further abduction, now known as **elevation** (Fig. 92), is produced by rotation of the scapula upon the chest wall by the trapezius and serratus magnus muscles This movement, in which the clavicle participates, takes place principally at the sterno-clavicular and acromio-clavicular joints, and is possible until the arm assumes the vertical position The complete range covered by the combined movements corresponds to an arc of 180 degrees.

C. P Martin† has shown that towards the end of abduction to 90 degrees the great tuberosity impinges against the acromial process of the scapula, and in order to pass beyond this point there is an external rotation of the head of the humerus Full elevation then becomes possible, and this movement is always therefore accompanied by external rotation of the head of the humerus At the termination of elevation the internal condyle of the humerus is directed forwards (Fig. 92) This fact has an important bearing upon the range of movement in injuries and diseases of the shoulder-joint. The frequent limitation of full outward elevation often present may in reality indicate that external rotation is restricted Similarly, full internal rotation is essential to the performance of extreme forwards elevation at the shoulder, and such limitation of the latter movement may be due to a limitation of internal rotation It is important, therefore, in manipulating the shoulder to ensure the recovery of full rotation before attempting to restore complete elevation. Additional reason is also apparent for treating injuries of the shoulder-joint in external rotation and abduction

Adduction, or depression of the arm in the frontal plane to the side, occurs through a similar range, and is then stopped by contact with the trunk If, however, the arm be then flexed, a further degree of movement inwards is possible through about 50 degrees (horizontal adduction) Movement outwards in this plane (horizontal abduction) is possible through 90 degrees

Rotation —In extreme elevation of the arm no rotation of the arm at the shoulder-joint is possible When the arm is at right-

* E A Codman, "The Shoulder," 1934 Boston, U S A
† *Brit Journ of Surgery*, July, 1932, p. 61

posterior plane, takes place to a similar extent, but is also possible behind the long axis of the body through about 45 degrees combined with scapular movement This latter movement is sometimes termed hyperextension

Abduction (Figs. 90 and 91), or movement outwards of the arm in



FIG 92 —ELEVATION OF ARM

The inferior angle of the scapula has travelled outwards and upwards and the head of the humerus rotated outwards

the frontal plane of the body, is possible through an arc of 180 degrees, the first 90 degrees taking place principally at the shoulder-joint. The supraspinatus, by steadying the head of the humerus against the glenoid cavity, and the trapezius and serratus magnus by fixing the scapula, assist the deltoid in abducting the arm to a

The general indications for manipulation in chronic arthritis have been mentioned in a previous chapter, to which reference may be made. Experience of manipulation of the shoulder in carefully selected cases of this nature has proved the benefit of this measure. When the disease is no longer active, but has left a crippled and stiffened joint, manipulation may be of infinitely more benefit than a prolonged course of such forms of physical treatment as massage, various forms of heat, and electrical treatment. Many cases which have been unsuccessfully treated for long periods by these methods may rapidly respond to manipulation. The results of manipulation in cases of periarthritis of the shoulder with resulting stiffness are usually good. Care must be taken to exclude tuberculous disease of the shoulder (caries sicca) and X-ray examination should always be carried out.

Prevention of Deformity.—The position which the arm tends to assume in the later stages of the more severe inflammatory affections of the shoulder-joint is one of adduction, slight flexion, and internal rotation. Experience teaches, however, that the best position, should ankylosis occur, is that in which the arm is abducted through 60 degrees at the shoulder-joint in adults (rather more in children), flexed through about 20 degrees and externally rotated through 15 degrees. Care should be taken that the elbow lies anterior to the mid-axillary line, and that the scapula retains its normal position of rest. If, then, a patient is seen with an acute condition of the shoulder-joint in which adduction is present owing to uncontrolled muscular spasm, the arm, as a preliminary measure, should be carefully, gently, and under anæsthesia if necessary, placed in the correct position, and retained thus during the acute stage until such time as early movement, wherever feasible, can be started As this is a rectification of position rather than a manipulative operation, it is not necessarily contra-indicated by the presence of active sepsis and of a raised sedimentation rate

As, in these early stages, the limitation of movement is largely due to muscle spasm, there is no great difficulty and very little danger about such a procedure if care be exercised. If our efforts to retain a movable joint fail owing to the acuteness of the inflammatory process, the arm is nevertheless in the best possible position for ankylosis. Moreover, by scapular movement a considerable degree of elevation is possible, so that such actions as shaving and brushing the hair can be performed. If our efforts to secure a movable joint are to be crowned with success, the position of election above mentioned forms the best starting-point for movements, and

angled flexion or abduction, rotation through about 90 degrees is possible With the arm hanging at the side, rotation is possible through a range of 135 degrees Thus rotation increases from nil in full elevation to a maximum when the limb is dependent.

Circumduction is a combination of the above movements in which the arm describes a cone, the apex of which is situated at the shoulder-joint

Gliding Movement.—During certain of the movements described above, a gliding movement of the head of the humerus takes place upon the glenoid surface of the scapula. It will be remembered that this is somewhat pear-shaped, and during abduction there is at first a slight degree of gliding downwards of the head of the humerus which is prevented from being excessive by the action of the supraspinatus. During flexion and extension, there is similarly a slight degree of gliding movement backwards and forwards of the head of the humerus upon the glenoid cavity. In certain traumatic and pathological conditions, this gliding movement takes place in excess, constituting a subluxation of the head of the humerus.

In many cases in which, at first sight, the movements of the shoulder appear to be unimpaired, a limitation of rotation can be detected by the valuable test of asking the patient to place the hand behind the back between the scapulæ; an obvious and painful limitation of movement may thus be clearly demonstrated

It is of considerable importance to distinguish clearly between the limitation of movement at the shoulder-joint and that due to fixation of the scapula A slight degree of limitation of movement at the shoulder-joint sufficient to give rise to much pain and disability may be entirely masked by compensatory scapular movement In some cases, there is limitation of both shoulder and scapular movement, and in others, limitation of movement is due to involvement of the subacromial or subdeltoid bursa. These facts must be borne in mind when investigating every case, and the range of movements should be tested both before and after fixation of the scapula.

Indications for Manipulation of the Shoulder-Joint.—Limitation of movement at the shoulder-joint by adhesions is apt to follow sprains, contusions, and dislocations of the joint, fractures of the neck or great tuberosity of the humerus, fractures of the acromion process of the clavicle or scapula, or of the glenoid process of the scapula, synovitis of a toxic or infective nature; and acute or chronic arthritis More rarely the limitation of movement may be due to causes outside the joint, such as scarring of the surrounding muscles following wounds, prolonged suppuration, or burns.

For instance, after first rotating, the limb is then adducted to the mid-line and again rotated. Still fixing the scapula, flexion and extension are next performed, each movement being followed up by rotation.

Next abduction is performed carefully, preferably with an assistant pressing upwards with the fist in the axilla to support the head of the humerus The fixation of the scapula may be aided by pressure by the assistant against its inferior angle. When abduction is complete, rotation is again carried out. The scapula may now be released and elevation, both forwards and outwards, executed.



FIG 93 —MANIPULATION OF RIGHT SHOULDER METHOD I LONG LEVERAGE

Circumduction through gradually increasing circles is next performed. This movement should be carried out combined with different degrees of rotation outwards and inwards of the humeral head This is a valuable method of breaking down the adhesions so commonly present in the anterior part of the joint capsule, this combination of varying degrees of rotation with varying degrees of circumduction being one of the secrets of success in manipulating the shoulder This movement is demonstrated in Fig. 94, which shows also the author's method of supporting the head of the humerus and preventing dislocation during this manœuvre. It will

should be maintained at first in the intervals between such movements.

Anæsthetic.—This is a manipulation which it is inadvisable to attempt to perform under gas in the treatment room or out-patient department. It is essential to abolish spasm, the presence of which predisposes to dislocation or fracture. Admission to nursing home or hospital for twenty-four to forty-eight hours with preliminary medication and a general anæsthetic is recommended Intravenous pentothal is a valuable form of anæsthesia.

Manipulative Technique.—In all cases of stiffness of the shoulder it is necessary to formulate a plan of campaign. Cases of true ankylosis in bad position are more suitable for open operation, such as osteotomy of the humerus to correct adduction, or in some cases arthroplasty Such operations, however, are not indicated where the ankylosis is fibrous or due to shortening of the capsule, peri-articular tendons, and other structures

If we are satisfied that the adhesions limiting movement are in or around the shoulder itself and do not affect the scapula, it is obvious that in the first stage of the manipulation we must attempt to fix the scapula, but in every case it is advisable to follow this by manipulation which includes scapular movement. It is difficult to exclude scapular or other peri-articular adhesions, and indeed such "free" movement, including the scapula, is, as noted below, the most potent method of breaking down certain adhesions in the shoulder itself

When limitation of movement is slight, a single manipulation may be sufficient to effect a cure. When, however, limitation is marked, as in many cases of periarthritis or "frozen shoulder" and in some of the more marked cases of traumatic adhesions, it is futile and dangerous to attempt to overcome this by a single manipulation Movement should be gradually restored by a series of manipulations separated by intervals averaging from 10-14 days, during which after-treatment is assiduously carried out. Some of the most obstinate types of stiffness will often improve to a marked extent by such a carefully planned series of manipulations. In cases of minor degrees of limitation of movement of the right shoulder, the scapula is fixed by the surgeon's left hand, the thumb pressing against the clavicle and the fingers against the spine of the scapula The patient's right forearm is grasped just below the elbow by the surgeon's right hand, and the joint is put through its full range of movements in a firm, steady, and purposive manner (Fig. 93)

It is advisable first to loosen the joint somewhat by traction and rotation, and to bear in mind that the amount of rotation normally possible varies with the position of the limb.



FIG 95 —MANIPULATION OF RIGHT SHOULDER METHOD 2. SHORT LEVERAGE



FIG 96 —MANIPULATION OF RIGHT SHOULDER METHOD 2 SHORT LEVERAGE.
During abduction of the arm the assistant presses firmly upwards into the axilla to prevent dislocation of the head of the humerus.

be noted that the movement of circumduction of the shoulder is often facilitated by the operator grasping the patient's wrist, particularly during the later stages of the manipulation.

In cases of more obstinate stiffness (Figs. 95 and 96) the scapula is fixed as above, but owing to the risk of fracture of the neck of the



FIG 94 —MANIPULATION OF RIGHT SHOULDER CIRCUMDUCTION
The head of the humerus is protected by the operator's right hand in the axilla

humerus or of dislocation, if a long leverage be employed, the other hand of the surgeon grasps the upper arm just below the axillary level. It is a wise measure to be content with a moderate increase of range of movement in all directions, rather than to risk fracture by attempting too much at first, and it should be remembered that too forcible rotation is the movement most likely to cause fracture.

When adhesions are of slight or moderate degree, and in the final stages of a case with marked adhesions, the patient should be placed in the semi-prone position and the operator should very carefully combine internal rotation with extension by attempting to place the patient's hand between the scapulæ, supporting the head and surgical neck of the humerus with his other hand (Fig. 97). This movement must be carried out with great care to avoid fracture of the surgical neck of the humerus.

At the risk of repetition, emphasis must again be laid upon the importance of carrying out all these movements with care, and of avoiding fracture of the surgical neck of the humerus during rotation by the methods already described In some cases, adhesions are present in the sheath of the biceps tendon These are best treated by extending the arm at the shoulder-joint while the patient is lying upon the opposite side or in the supine position with the affected shoulder projecting beyond the edge of the couch. The elbow should simultaneously be extended.

Manipulation of Shoulder—Illustrative Cases.—One of the most frequent causes of stiffness of the shoulder is too prolonged immobility after the reduction of a dislocation of the shoulder-joint. If the stiffness and limitation of movement be slight, a single manipulation will often be sufficient, but in more marked degrees it is wise to perform a series of manipulations.

CASE I —Major M P After excessive use of the right arm in farming began to experience pain and stiffness of right shoulder, this had been present for four months Had a course of electrical treatment without benefit, X-ray showed no osseous abnormality

On Examination —Tenderness over outer surface of deltoid and region of coracoid process Any attempt by patient to raise arm above shoulder level painful, as also extremes of rotation

Passive movements above shoulder level comparatively free

July 24, 1945 Manipulation of right shoulder under pentothal anæsthesia Full movements obtained and re-educational exercises started immediately

July 26, 1945. All movements both active and passive of affected shoulder complete and painless. Was soon able to resume bowling at cricket.

CASE II —M , aged 20, fell from his bicycle on to the left shoulder, which was dislocated This was reduced the next day, massage was begun immediately, and movements after ten days Movements gradually increased, and after a while he was able to resume playing games, although very slight limitation of elevation, extension, and circumduction remained, which interfered with bowling Recently the pain in the left shoulder had increased

In such obstinate cases, the arm may be retained in abduction, associated with about 20 degrees of flexion and the mid-position of rotation, in an abduction splint, or in a reinforced plaster case, in the intervals of massage and movements This is, however, not always necessary.

Scapular adhesions can in most cases be dealt with by the manip-



FIG 97 —MANIPULATION OF RIGHT SHOULDER EXTENSION COMBINED WITH INTERNAL ROTATION

ulations described above In cases of difficulty, the patient is placed in the semi-prone position, so that the vertebral border projects Direct pressure and traction can sometimes be effectually applied by grasping the vertebral and axillary borders and forcibly pushing the scapula from side to side and from above downwards upon the chest wall

replacement was not considered advisable. The anatomical neck of the humerus lay against the glenoid margin There was a complaint of "neuritis" in the arm, and considerable stiffness and limitation of movement at the shoulder-joint.

Manipulation was performed with extreme care As was expected, it was found impossible to reduce the dislocation, but the movements were increased nearly 50 per cent., and functional use of the limb was in consequence considerably improved

CASE V —A medical man complained of marked stiffness of the right shoulder, and very severe pain, not only in the joint, but in the whole limb, principally in the musculo-spiral nerve distribution. Wasting of the muscles of the shoulder-girdle and arm was present, and flexion and abduction of the arm were limited to 90 degrees, including scapular movement He had previously been treated by manipulation elsewhere, but the joint restiffened, probably because an attempt was made to regain full movement at one session. He was depressed and exhausted by pain and sleepless nights

The history of the patient's condition is given in the following abstract supplied by the patient:

"*History of Accident* —On November 1, going down ice-cased steps, heels went from under me. Both arms were flung involuntarily upwards, outwards, and backwards Very distinct sensation of a 'snap' in region of right shoulder-joint, with excruciating pain which lasted some minutes Diagnosis Tear of muscle Pain continued; movements caused increased pain

"*Treatment* —Rest, support of arm, hot baths and later massage.

"*December* 15 —Condition slowly improving, boring pain in region of joint, occasional intervals of freedom from pain; movements, unless quite gentle, caused increased pain Inadvertent abduction and rotation particularly caused very severe pain at deltoid ridge of humerus, as well as about the head of humerus

"*January* —X-ray showed no fracture

"*Treatment* —Radiant heat, artificial sunlight, massage, and passive movements for three weeks Pain worse, deep boring ache in joint Diagnosis: 'Tear of capsule.'

"*February* —Advised more complete rest, with sling and bandage.

"*April.*—Pain rather worse, especially at night, painful areas about scapula and down arm to the hand, chiefly radial side.

"Painful stiffness of the whole arm, especially in mornings Movements limited; adhesions formed

"*April* 30 —Nursing home; general anæsthetic Adhesions broken down, arm put through considerable movements, and fixed in full elevation.

"*Result* —Pain on moderate abduction no longer occurs, but otherwise pain just as bad as before Treatment since then · Radiant heat, massage, and passive movements.

On Examination.—Full elevation of arm both forwards and outwards slightly restricted and painful. Extension, rotation, and circumduction similarly restricted.

Tenderness was present over the front of the shoulder-joint.

Manipulation was performed by the usual technique for slight degrees of stiffness, and exercises and re-education were instituted immediately. The patient made a rapid recovery.

CASE III.—Mrs M., aged 50, complained of pain in the left shoulder and down the inner side of the arm extending to the hand, together with limitation of movement of the shoulder-joint. She had an attack of rheumatic fever at the age of eleven years, since which she had been subject to attacks of "rheumatism," particularly in the arms and legs. The pain in the left shoulder and arm had been much more marked during the past twelve months. She had been treated at a spa with applications of peat to the shoulder, which had been immobilised for a long period. She had also had more recently a long course of electrical treatment, massage, and movements, which gave some relief. The inability to raise the arm above shoulder level was, however, a considerable inconvenience.

On Examination.—Abduction of the arm was possible to an angle of 90 degrees with scapular movement, the actual movement at the shoulder-joint itself being slight. All other true shoulder movements were limited by 50 per cent. There was well-marked wasting of the muscles of the shoulder-girdle and upper arm. Crepitus was present on movement, and X-ray examination showed evidence of chronic arthritis of the shoulder-joint, but no obvious osteophytes were present.

As previous massage and exercises had actually caused a diminution of pain, it was decided to manipulate the shoulder, and to follow this treatment by exercises to maintain the increase of movement obtained. Manipulation was accordingly performed under general anæsthesia. The scapula was fixed, and the arm first carefully abducted. During this movement adhesions were felt to give way. Full abduction was thus obtained, and, on releasing the grip on the scapula, full elevation. The remaining movements of the shoulder were then attained by further manipulation. The patient remained in bed for twenty-four hours, during which the limb was retained in almost full elevation by means of a Thomas's extension arm splint with movable ring. Massage was instituted almost immediately, and movements at the end of twenty-four hours.

The patient derived great benefit, for pain was appreciably lessened, and the restoration of movement, particularly of elevation, was preserved by appropriate exercises, and enabled the patient to carry out acts previously impossible.

CASE IV.—Mrs S. dislocated left shoulder some months before. Apparently the dislocation was overlooked. She declined open operation, and owing to the time that had elapsed, manipulative

External Lateral Ligament.—Stretches between the lower part of the external epicondyle and the annular ligament.

Synovial Membrane.—Lines the deep surface of the capsule, the floors of the olecranon, radial and coronoid fossæ, and covers the deep surfaces of the pads of fat lying in these fossæ, which intervene between the capsule and the synovial membrane (Fig. 98). It sends a protrusion downwards to line the capsule of the superior radio-ulnar joint.

Movements (Fig. 99)—At the elbow-joint proper, movements of flexion and extension occur. Owing to the obliquity of the trochlear surface of the humerus, the forearm on flexion inclines inwards and

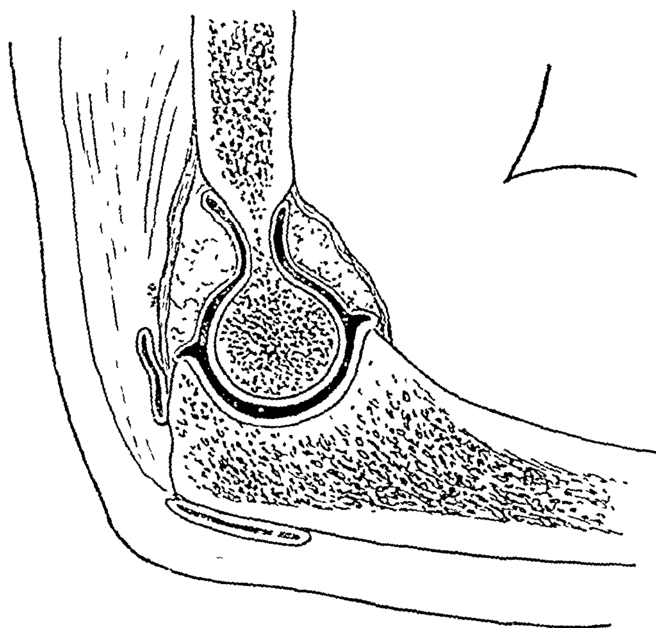


FIG. 98—SAGITTAL SECTION OF ELBOW-JOINT

brings the hand towards the mid-line. On extension, the forearm inclines outwards, and on full extension makes an obtuse angle with the upper arm, sometimes known as the "carrying angle." Extension is possible to a straight line, although in some persons a few degrees of hyperextension are normally allowed Flexion takes place until the forearm forms an angle of 45 degrees with the base line.

SUPERIOR RADIO-ULNAR JOINT.—This is a pivot-joint. The annular or orbicular ligament, which forms three-quarters of a circle, surrounds the head of the radius, and is attached to the anterior and posterior margins of the lesser sigmoid cavity of the ulna. It narrows

"*Result*—Movements improving, but pain, if anything, has been more severe, at times much more so down the arm to hand Fingers have been a little swollen this week, and I think the arm also a little Rarely sleep through the night, owing to severity of boring pain"

It was decided to attempt to restore full movement to the shoulder by a series of manipulations At the first manipulation, which was performed under gas and oxygen anæsthesia, a 50 per cent. increase of movement was obtained The arm was temporarily retained in abduction through 45 degrees by sand-bags Radiant heat, massage, and movements were commenced the same day and continued daily A fortnight later, a second manipulation under gas and oxygen was performed, and movement still further increased. A month later, the increased range was still maintained, pain was considerably less, and muscular power was improved Internal rotation was, however, still somewhat restricted A third and final manipulation was therefore carefully performed under chloroform and ether anæsthesia, resulting in almost complete recovery of rotation After a few more weeks of radiant heat, massage, and exercises, the movement of the shoulder was found to be perfect, pain was negligible, and the patient's general condition was so far improved that he was able to resume professional work

(B) THE ELBOW-JOINT

Surgical Anatomy (Fig 98).—The elbow is a hinge-joint in which the greater sigmoid cavity of the ulna articulates with the trochlear surface, and the radial head with the capitellum of the humerus It depends for its strength more upon the shape of its articular surfaces than upon surrounding ligaments. In connection with this articulation we must also consider the superior radio-ulnar joint, the synovial membrane of which is directly continuous with the elbow-joint. At the superior radio-ulnar joint the head of the radius articulates with the lesser sigmoid cavity of the ulna

Ligaments.—The articular capsule is strengthened at certain spots. The *anterior ligament*, which is somewhat weak, is attached proximally to the margins of the coronoid and radial fossæ, and to the internal condyle, and below to the margins of the coronoid process and to the orbicular ligament

The *posterior ligament*, also weak, is attached above to the margins of the olecranon fossa and to the external condyle, and below to the anterior and lateral margins of the olecranon process

Internal Lateral Ligament.—Is triangular in shape. The apex, which is above, is attached to the internal epicondyle of the humerus. The base is attached to the inner margins of the coronoid and olecranon processes, and to a transverse ligament which bridges across this interval.

limb. In adults, however, and occasionally in children, manipulation may be necessary. Manipulation may be necessary also after dislocation, and occasionally after operations and after muscular sprains in the vicinity of the joint.

Manipulation is not infrequently of value in the stiffened arthritic elbow-joint. In many of these cases, the joint has become fixed midway between flexion and extension, and the resultant disability is great, as the patient is unable to bring the hand to the mouth or head. It is often possible by manipulation to enable the patient to perform these essential functions and thus refute those who



FIG 100 —MANIPULATION OF RIGHT ELBOW. FLEXION

dogmatically state that manipulation of the elbow should never be performed.

Among the causes of stiffness of the elbow are tuberculous disease (particularly in children) and myositis ossificans. In both of these conditions, manipulation is absolutely contra-indicated. We have already referred to the importance of X-ray examination of a joint before having recourse to manipulation, and this rule applies with particular emphasis to the elbow-joint.

Technique of Manipulation (Figs. 100 and 101).—A common error is to manipulate the joint forcibly and with an absence of proper method, and it is scarcely surprising when, as so often happens,

where it encircles the neck of the radius, to which it is very loosely attached, so that the bone is enabled to rotate upon its own axis Fibres of the anterior, posterior, and external lateral ligaments of the elbow are attached to its corresponding surfaces, and some fibres of the supinator brevis arise from its outer surface. A thickened band which passes from just below the lesser sigmoid cavity of the ulna to the neck of the radius is known as the quadrate ligament.

The *Synovial Membrane* of the joint is continuous with that of the elbow-joint.

Movements.—A purely rotatory movement of the radial head, which brings about pronation and supination of the forearm.

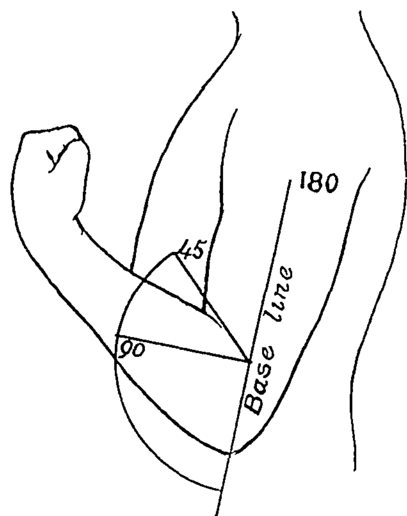


FIG 99 —MOVEMENTS OF ELBOW

Prevention of Deformity.—The elbow-joint when in a state of inflammation tends to become fixed in a position midway between flexion and extension with the forearm pronated The best position for ankylosis is probably when the arm and forearm form an angle of slightly less than 90 degrees at the joint, as this position permits the hand to be brought to the mouth or the head. The occupation and wishes of the patient should, however, always be considered, as some persons would doubtless prefer the elbow-joint to be fixed at a different angle. If both elbows are affected, it is advisable that one should be fixed at rather less and the other at rather more than a right angle.

When, therefore, we are faced with a somewhat acute condition of the elbow-joint in which fixation by muscle spasm in a position of deformity has occurred, the forearm must be gently moved into the optimum position and retained thus temporarily

Indications for Manipulation of the Elbow.—Stiffness of the elbow-joint may follow injury or disease A painful limitation of movement may follow fracture in the region of the joint, particularly if reduction has not been satisfactory or if too prolonged rest has been insisted upon. If reduction has been faulty, the radiograph will probably show that the limitation of movement is due to bone, and manipulation in these cases is useless In children, the stiffness of prolonged immobility often recovers completely with use of the

otherwise is liable to fracture, while the thumb of the same hand, by firm pressure on the head of the radius in the antecubital fossa, prevents dislocation forwards of this bone during extension. The other hand of the surgeon firmly grasps the forearm in the middle or lower thirds. Then by slow, steady pressure, rather than by any form of jerking movement, the resistance to flexion and extension is gradually overcome Both these movements are carried out with the forearm fully supinated and also in pronation and semi-pronation. When adhesions are of a dense nature, the plan of gradually overcoming the obstruction to movement by a series of manipulations should be adopted. The reason for such a procedure is that, in severe cases, adaptive shortening of muscles and other structures occurs, particularly on the side of flexion If, therefore, at one manipulation an attempt be made to restore full movement, a severe sprain may result from rupture of muscular, tendinous or ligamentous fibres.

To manipulate the superior radio-ulnar joint, the movements of pronation and supination are performed first with the elbow fully flexed. The elbow is then gradually extended, and during this movement rotatory movements are continued until full extension is reached

"Pulled Elbow."

This condition may occur, particularly in children, and is due to sudden traction upon the wrist or hand, as in lifting a child from the ground The radius is capable of a small degree of movement in a longitudinal direction upon the ulna, and, by traction upon the wrist or hand, it may be pulled downwards at the superior radio-ulnar joint, a subluxation with locking taking place The elbow is fixed in semiflexion and midway between pronation and supination, and all joint movement is painful. It appears that the coronary ligament is interposed between the head of the radius and the capitellum The manœuvre to unlock the joint is similar to that described above for the superior radio-ulnar joint.

Manipulation of Elbow—Illustrative Cases.

CASE I —A young woman fell from a tree, sustaining a dislocation of the left elbow associated with a split fracture of the internal condyle of the humerus The dislocation was reduced almost immediately and early movements begun No attempt was made temporarily to place the elbow in full flexion in the intervals of massage and movements, and the joint steadily became more and more stiff Eleven weeks later the elbow was manipulated elsewhere, but again the position of full flexion was not insisted upon, and the elbow restiffened.

the elbow promptly restiffens This joint is one in which the principle of gradually restoring movement by a series of manipulations is particularly indicated

The rule in these cases is to restore flexion at first, when the extension can usually be relied upon to return gradually, provided the movement is not unduly forced The forearm is bandaged in flexion, and extension gradually restored by active movements.

Each day, as we gradually win a few more degrees of active extension, care must be taken that the patient actively bends the elbow into full flexion, as otherwise the gain of extension may occur at the expense of a loss of flexion.

Massage and forced movements must be strictly avoided, as they



FIG 101 —MANIPULATION OF RIGHT ELBOW EXTENSION

Note that the surgeon's left thumb presses upon the head of the radius to prevent dislocation forwards of the latter

frequently lead to restiffening of the joint by spasm, and may be a cause of myositis ossificans in traumatic cases.

When minor adhesions are present, the long leverage is preferable For instance, in manipulation of the right elbow, the surgeon grasps the lower end of the upper arm in the region of the back of the joint with his left hand, and the forearm just above the wrist with his right hand Flexion of the elbow is first performed, and then extension is carried out in three positions of the forearm—viz., supination, pronation, and the mid-position. The elbow is next fully flexed and then gradually extended, and during the whole of the latter movement pronation and supination of the forearm is performed. In the case of more dense adhesions, one hand grasps the back of the elbow and supports the olecranon process, which

cure, and, in the case mentioned above, these adhesions could probably have been prevented by an appreciation of the value of early active movements.

Manipulation in "Tennis Elbow."

This is a common and important condition, and as there exist many theories of its causation, the exact pathology cannot yet be said to rest upon a sound basis.

During the period when the underhand forehand drive was more in vogue than at the present day, the most characteristic form of "tennis elbow" was one in which pain and tenderness were present just above the internal condyle of the humerus, and in some cases at the insertion of the pronator radii teres

In modern times, pain and tenderness are most marked upon the outer side of the joint, the former symptom being also often felt over the radial extensors of the forearm The symptoms are either of gradual onset, or more frequently there is a somewhat acute onset after playing an unusual amount of tennis, particularly at the beginning of the season. The tenderness is usually localised, and may be situated (*a*) over the tip of the external epicondyle of the humerus, (*b*) over the outer and anterior aspect of the superior radio-ulnar joint. Occasionally tenderness is present at some more atypical spot or at more than one of these sites, and in early and acute cases there may be more generalised pain and tenderness over the supinator and extensor muscles It is probable that these represent different types of "tennis elbow." Before discussing these pathological types, it is necessary to refer briefly to the ætiology.

In gripping the handle of a tennis racket firmly, the flexor muscles on the anterior aspect of the forearm play a principal part, but the extensors can also be felt to be in a state of tension At the moment of impact in making a drive, the tension of the extensor group is suddenly increased and a sprain may occur at their common origin from the external epicondyle. This ætiological factor is perhaps of greater importance than the back-hand stroke. The grip factor is of great importance

A writer in the *Journal of the Naval Medical Service* pointed out that he had treated three cases of "tennis elbow" in men who had never played tennis, but who were hammermen in Sheerness Dockyard. In these cases also, the symptoms were probably caused by the sudden increase in tension at the origin of the extensor muscles caused by each blow of the hammer. The condition was quite

On Examination—One month after the above-mentioned manipulation, the left elbow was held at an angle of 135 degrees Extension beyond this point was prevented by painful muscular spasm. Flexion was possible to an angle of 90 degrees, but beyond this was restricted by muscle spasm Pronation and supination were complete X-ray examination showed no evidence of myositis ossificans, but evidence of slight previous injury to the inner condyle of the humerus It was decided in this case to endeavour to restore movement gradually by at least two manipulations, retaining the elbow in as full flexion as possible as the position of rest after each manipulation

First Manipulation—Flexion and extension very carefully and gradually increased until limited by about 20 degrees The elbow was flexed as fully as possible, but released daily for radiant heat, effleurage, and movements, particular attention being paid to active movements in the direction of extension

Second Manipulation—A week later almost complete movement was obtained, and similar after-treatment followed The position of full flexion was maintained in the intervals between treatments for a fortnight, and at the end of this period almost complete and painless active movements were present, and have been maintained

CASE II—Mrs W, ten months previously, fell on the outstretched right hand Slight transient pain and discomfort occurred in the right elbow-joint, and a week later she noticed stiffness in the same joint and slight limitation of extension The whole arm ached, particularly after use The limb was immobilised for several weeks, but on attempting to use it again the same symptoms recurred Immobilisation was again ordered, and altogether the limb was rested for many months Tuberculous disease was suspected, but not confirmed by X-ray examination

On Examination—There was no swelling of the joint and no enlargement of the articular ends Pain was caused by full flexion and on extension, the latter movement being slightly restricted Slight muscular wasting and tenderness upon the outer side of the joint were present, but there was no raised temperature over the joint. Adhesions following traumatic synovitis were diagnosed, and manipulation was performed under gas followed by immediate re-education

Result—Rapidly cured

The symptoms in this case were characteristic of many cases in which adhesions are present. Use of the joint causes pain and swelling, and immobilisation is ordered Further use again gives rise to the same symptoms, and immobilisation is again ordered. This sequence of events is often spread over a very long period—sometimes years—and, not infrequently, the medical adviser begins to suspect tuberculous disease Manipulation by breaking down the adhesions which are the cause of the symptoms usually results in rapid

tion in this type is often accompanied by a click or snap and almost immediate relief.

In the third type, it is probable that the condition is more of the nature of a periostitis without adhesions (epicondylitis).

Experience shows that the types of tennis elbow which are associated with painful limitation of some movement respond best to manipulative measures. When periostitis is the most prominent factor, it is difficult to see how manipulation can be of any avail, and in these cases abstention from playing for a while, with electrical treatment (ionisation or short-wave diathermy), and one or more injections of the tender area with novocaine or procaine, are the best treatment. Physical treatment should, needless to say, always be given a trial even when adhesions are present, as in many minor forms it effects a cure. Manipulation should be reserved for the more obstinate types, or if speedy recovery is a matter of urgency.

Manipulative Technique.—Under gas, gas and oxygen or intravenous pentothal, or some other short anæsthesia giving adequate relaxation, the elbow is first fully flexed and then fully extended. The elbow is then fully flexed again, and while exercising firm thumb pressure upon the outer side of the joint, rapid rotatory movements are performed as the manipulator slowly passes from full flexion to full extension. The same movement is again repeated, but with the patient's fingers fully flexed into the palm and the hand flexed at the wrist-joint. Next " the elbow is forced into full extension with the wrist and fingers flexed and the forearm pronated. At the same time, in epicondylar cases firm pressure is made over the tender point with the thumb of the hand which is controlling the elbow."*

When symptoms point to a nipped fringe of the coronary ligament or synovial membrane a valuable additional technique consists in forcibly adducting the extended forearm and thus opening up the outer side of the joint. This manœuvre is often accompanied by a loud snap and immediate relief, and it is clear that some form of internal derangement of the superior radio-ulnar joint has been reduced

Case III, an obstinate case of tennis elbow occurring in a surgical colleague, was recently treated in this way (see p. 195).

After manipulation for tennis elbow, although there is usually an immediate improvement, the symptoms may persist in a modified form for a short while. It is wise, therefore, to prescribe a ten to fourteen days' course of infra-red and special exercises, and the patient should not be allowed to play tennis for two or

* G Percival Mills, *Brit. Med Jour*, July 31, 1937

frequent during the war in elderly people who filled and carried sandbags

Sufferers from "tennis elbow" frequently find the gripping of objects painful, and the normal co-ordination between the flexors and extensors is so far disturbed that, in many cases, there is sudden loss of power in attempting to lift quite light objects

On routine examination of a case of "tennis elbow," it will often be found that if after flexing the fingers and wrist the elbow be extended and then pronated, pain will be experienced over the site of origin of the common extensor group, in some cases, both flexion and extension of the elbow are slightly restricted and painful.

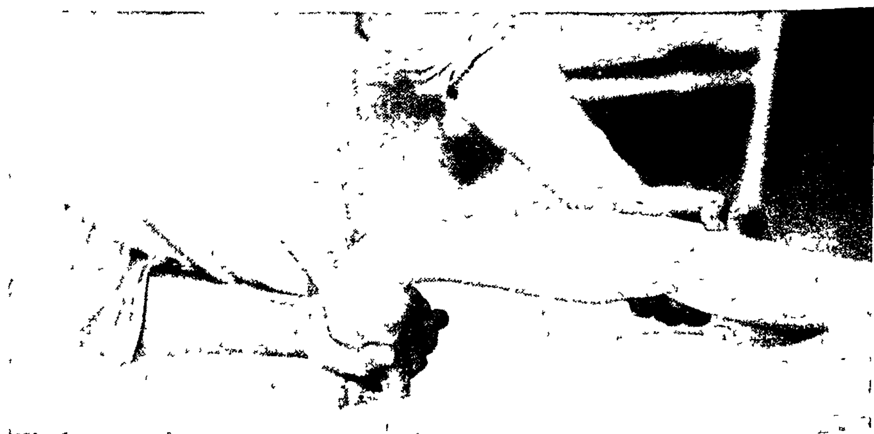


FIG 102—MANIPULATION FOR "TENNIS ELBOW" EXTENSION OF THE PRONATED RIGHT FOREARM WHILE WRIST AND FINGERS ARE SIMULTANEOUSLY FLEXED

Note—Pressure by the surgeon's left thumb over the external epicondylar region

In another type of case, flexion or extremes of rotation at the superior radio-ulnar joint give rise to pain or are slightly restricted In a third type, no pain on movement can be elicited, but well-marked tenderness is present over the external epicondyle or slightly above this area

In the first type, it seems probable that the condition is either scar-tissue in the tendinous common extensor origin, or adhesions between the tendon and the underlying epicondyle.

In the second type, it is probable that the condition is one either of adhesions in the superior radio-ulnar joint, or of nipped synovial fringe or coronary ligament It is an interesting fact that manipula-

weeks later the patient played in a tournament lasting six hours without discomfort, and the cure has been maintained

CASE III.—A surgical colleague writes as follows

In Spring, 1938, while standing in our pond in the garden, catching goldfish for purposes of clearing the pond, I experienced sudden acute pain in the right elbow, causing me to drop the net. The pain continued for approximately five weeks, making it difficult to carry out operations It gradually went spontaneously.

I consider that this was possibly an early manifestation of osteoarthritis I had my teeth X-rayed, and most of the upper ones extracted.

No further trouble until about two and a half months ago. There was no specific accident on this occasion, but it came on a few days after I had a very tiring prostate to remove. My arm ached after this for a day or two, and I think I can remember knocking the elbow. The pain on putting on Spencer Wells' was much worse than on the former occasion, and it drove me to trying physiotherapy. I had massage, infra-red and various local applications, which included iodex and histamine ointment.

The relief after the manipulation (October 6, 1946) was immediate A dull ache has continued, but I am now able to play golf and operate in comfort After a heavy day's operating the pain comes on, but it is better by the next morning.

I am most impressed by the dramatic improvement.

(C) THE WRIST-JOINT

Surgical Anatomy (Fig. 103).—A condyloid joint at which the lower articular surface of the radius with the triangular fibrocartilage form a concave surface which articulates with the convexity formed by the upper surfaces of the scaphoid, semilunar, and cuneiform bones.

An *articular capsule* surrounds the joint, and is strengthened by the following ligaments.

Anterior.—Is attached above to the anterior border of the lower extremity of the radius and to the anterior surface of the head of the ulna, and its fibres pass downwards and inwards, and are attached to the anterior aspect of the bones of the proximal row of the carpus

Posterior —Is attached above to the posterior border of the lower end of the radius, and its fibres also pass downwards and inwards to be attached to the dorsal aspects of the bones of the proximal row of the carpus.

Internal Lateral.—A rounded cord attached above to the styloid process of the ulna, and below to the inner surface of the cuneiform and to the pisiform.

three weeks, and then is advised to use discretion at first and resume gradually. Cure may be anticipated by these measures in about 85 per cent of cases of tennis elbow in which limitation of movement was previously present. In the cases that do not respond, it will often be found that some toxic focus such as an infected tooth is responsible for the persistence of symptoms

Illustrative Cases.

CASE I.—Miss H , social worker. In July, 1945, after playing tennis, noticed pain on the outer side of the right elbow and in forearm and fingers. Rested for a month, but pain recurred when she played tennis again If she wrote for any length of time or lifted a bag she felt a sharp pain on the outer side of the right elbow Had a three months' course of infra-red and other forms of physical treatment at a teaching hospital without benefit

On Examination —Classical signs of tennis elbow.

Manipulation of the right elbow was performed under nitrous oxide on March 13, 1946. No special physiotherapy was prescribed afterwards, but she was instructed to immerse the elbow in hot water three times daily and to perform special exercises

On April 28 she played several sets of tennis and stated that the only part of her body that did not ache was the previously affected elbow!

CASE II.—Miss S., physiotherapist Complained of all the typical symptoms of "tennis elbow," and the condition very seriously interfered with her work. The onset and course of the condition are described in the following personal account by the patient "Recently I drove a car with very heavy gears and no self-starter, and must have overstrained my arm without realising it Shortly after, I played in a tennis match, and could hardly carry on, as there was a sickening pain in the elbow, and back-handers were almost an impossibility The pain seemed to be between the bones of the outer side of the elbow-joint, as if a red-hot poker were pushed between A definite spot on the bone hurt on pressure, as did also the upper part of the outer side of the forearm When movement took place, there were sharp stabs of pain in the elbow-joint which shot down the outer side of the forearm I was unable to grip anything, to lift a cup, or even to shake hands without considerable pain For the first few days the fingers were swollen The elbow was treated with ionisation, radiant heat, massage, and complete rest for four weeks. Then finger exercises, etc , were started, and at the end of five weeks the elbow was as bad as ever I was unable to grasp a racquet without the *same* degree of pain as I had before the five weeks' complete rest and treatment After the manipulation, the result was immediate I shook hands without pain, and was able to drive the car home (five miles) immediately afterwards without a twinge I have played tennis every week-end, and have had no pain in the elbow whatsoever. Back-handers and even hard back-hand volleys do not hurt it now." Three

Abduction, or radial flexion, is possible through approximately 35 degrees, at which angle further movement is blocked by the styloid process of the radius coming into contact with the carpus It is less free than—

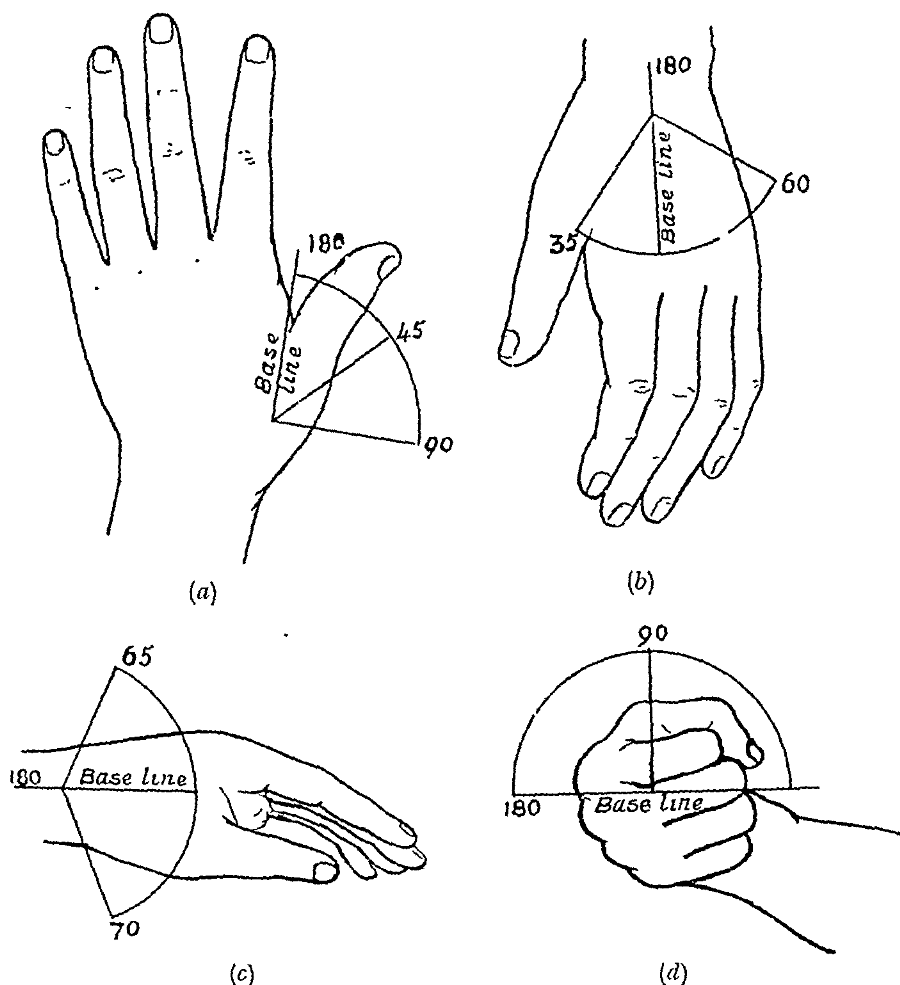


FIG. 104.—DIAGRAMS SHOWING: (*a*) RANGE OF EXTENSION OF THUMB; (*b*) ABDUCTION AND ADDUCTION OF WRIST, (*c*) FLEXION AND EXTENSION OF WRIST; (*d*) PRONATION AND SUPINATION OF FOREARM

Adduction, or ulnar flexion, which is possible through approximately 60 degrees.

Circumduction is a combination of these movements.

INFERIOR RADIO-ULNAR JOINT (Fig. 103).—At this joint, the head of the ulna articulates with the lesser sigmoid cavity of the radius laterally, and with the triangular fibro-cartilage below.

Articular Capsule.—Is very weak proximally, but is strengthened

External Lateral.—Is attached above to the styloid process of the radius, and below to the tuberosity of the scaphoid and to the trapezium.

Synovial Membrane.—Is loose and lax and lines the deep surface of the capsule. The synovial cavity does not communicate with that of the inferior radio-ulnar joint.

Movements (Fig. 104).—The following are permitted. flexion, extension, abduction, adduction, and circumduction.

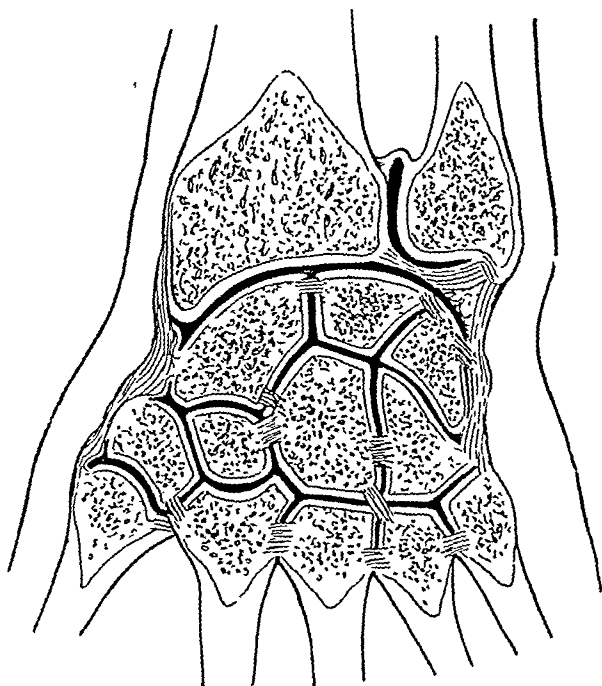


FIG 103—CORONAL SECTION THROUGH WRIST, INFERIOR RADIO-ULNAR, CARPAL AND CARPO-METACARPAL JOINTS TO SHOW ARRANGEMENT OF SYNOVIAL CAVITIES

It must be remembered that in these movements the intercarpal and carpo-metacarpal joints participate to a certain extent.

Flexion is possible through 70 to 90 degrees with the fingers extended, and through somewhat less with the fingers flexed.

Extension or dorsiflexion is possible through about 65 degrees with the fingers extended, and to a somewhat greater degree when the fingers are flexed. It is interesting to note that flexion at the wrist-joint proper is in reality more limited than extension, but this is more than compensated by movement at the intercarpal and carpo-metacarpal joints.

remembered that adhesions are also present in the carpal and inferior radio-ulnar joints, and in the sheaths of the flexor or extensor tendons, or, indeed, may be confined to the latter. Careful examination will usually elicit some localised spot of tenderness and painful limitation of some particular movement. When the inferior radio-ulnar joint is involved, there is interference with pronation and supination, and of the normal gliding movement of this joint, in addition to the movements of the wrist-joint proper.



FIG 105—MANIPULATION OF LEFT WRIST EXTENSION COMBINED WITH TRACTION

Manipulation has proved disappointing as a rule in de Quervain's stenosing tendo-vaginitis, which is a condition affecting the tendon sheath of the extensor ossis metacarpi pollicis and extensor brevis pollicis tendons. These occupy the first compartment on the dorsal surface of the radius, near the styloid process.

Manipulative Technique.—The surgeon with one hand takes a firm grip of the patient's hand, and with his other hand grasps the forearm just above the wrist It will be found an advantage if, when extending the wrist, the surgeon grasps the forearm in such a manner

in front and behind by accessory bands—the anterior and posterior radio-ulnar ligaments.

Triangular Fibro-Cartilage.—This is attached by its apex to a pit between the head and styloid process of the ulna, and by its base to the ulnar border of the lower articular surface of the radius. It is an important bond of union between the lower ends of the radius and ulna, and during pronation and supination its ulnar attachment is the centre of a movement, in which the lower end of the radius carrying the hand revolves around the lower end of the ulna. During this rotation there is also a certain amount of antero-posterior gliding movement of the radius upon the ulna. Both surfaces of the triangular cartilage are covered with synovial membrane.

Synovial Membrane.—Is very lax, and bulges above between the radius and ulna in the form of the recessus sacciformis.

Movements at Radio-Ulnar Joints (Fig. 104 [*d*]).—At these joints, the movements of pronation and supination take place, the axis of movement passing through the head of the radius and the apex of the triangular fibro-cartilage. In full supination, the radius and ulna are parallel, and the thumb is directed outwards If we exclude shoulder movement, pronation—during which the radius crosses over the ulna so that the thumb is directed inwards—is possible through an arc of about 180 degrees. Quite frequently the normal range of rotation does not exceed 160 degrees. If, however, we include rotatory movement at the shoulder-joint, starting from the fully supinated position, the forearm can be rotated through some 270 degrees until the palm and flexor surface of the forearm are directed outwards.

Prevention of Deformity.—In any marked inflammatory condition of the wrist, the hand tends to assume a flexed position similar to that seen in "drop-wrist." When the hand is allowed to become fixed in such a position, the thumb and fingers are placed at a serious functional disadvantage, and the usefulness of the hand is markedly impaired During such conditions, therefore, the position of rest should be a moderate degree of dorsiflexion or extension—viz., about 20 degrees—maintained by a "cock-up" splint, or preferably a plaster slab, which does not interfere with the movement of the thumb and fingers and which can be removed periodically for treatment

Indications for Manipulation.—Among the commonest causes of stiffness of the wrist are fractures in the region of the joint, particularly Colles's fracture of the radius, in which there has been prolonged immobility; neglected sprains and contusions; and synovitis and chronic arthritis. In many of these forms, it should be

arthritis of the rheumatoid type, much may often be achieved by a series of manipulations separated by short intervals.

After-Treatment.—In slight or moderate degrees of adhesions, no retentive apparatus is necessary, and immediate movements are instituted to consolidate the improvement gained by the manipulation. In more marked cases, temporary retention in the corrected position by some form of adjustable cock-up splint or by means of a moulded plaster slab, which can be readily removed for early after-treatment, is desirable.

Manipulation of Wrist—Illustrative Cases.

CASE I.—H. W P., aged 16, stumbled over a football and fell on the back of the right wrist Marked pain, swelling, and bruising of the dorsum of the wrist followed, and an X-ray showed a fracture of the ulnar styloid A " cock-up " splint was applied, and kept on for three weeks without being removed. After removal of the splint, massage was ordered

On Examination—Five weeks after the injury, some swelling of the wrist was present, with localised tenderness over the styloid process of the ulna All movements of the wrist were slightly restricted and painful, and pronation and supination were both limited by 25 per cent Manipulation was performed under gas, during which adhesions were heard to give way and full movements obtained Early radiant heat, massage, and movements were prescribed, by which the increased movement was consolidated.

CASE II —Mrs —— had an attack of rheumatic fever, after which the right wrist-joint became affected with arthritis She was treated by radiant heat and massage, but no attempt was made to prevent deformity, and the wrist became fixed in 45 degrees of flexion Preparations were made for open operation, but while under the anæsthetic it was found that full movement could be restored by manipulation alone The hand was temporarily fixed in a " cock-up " splint in extension Movements were commenced after twenty-four hours, but the splint worn in the intervals for a week to maintain extension The function of the hand was, in consequence, considerably improved

CASE III —T P. strained right wrist playing golf Complained of pain on dorsum of hand, and weakness of grip

On Examination—Slight swelling and tenderness over common extensor sheath on dorsum of hand. Full palmar flexion of wrist, particularly with the fingers flexed into palm, caused aggravation of the pain A diagnosis of slight adhesions in the extensor sheath was made An anæsthetic was declined, but the fingers were flexed into the palm and the wrist smartly flexed, while firm thumb pressure was maintained upon the previously tender spot The patient was immediately cured

that the palm of one hand lies upon the extensor surface of the patient's forearm and the palm of the other hand is in contact with the patient's palm (Fig. 105). The technique employed in flexion of the wrist is shown in Fig. 106. Lateral and circumductory movements are next carried out by grasping the patient's hand in the hand-shaking position. During all these movements, it is important that firm traction should be exercised. In many cases



FIG 106—MANIPULATION OF RIGHT WRIST FLEXION COMBINED WITH TRACTION

adhesions are not confined to the wrist-joint proper, but involve also the transverse carpal, intercarpal and inferior radio-ulnar joints. The manipulations described are sufficient to deal with these adhesions also, provided the gliding movement of the lower end of the radius is restored by fixing the head of the ulna and firmly moving the radial extremity in a backwards and forwards direction. When stiffness is marked, as in neglected cases of Colles's fracture, and in

necessary to state that from medico-legal and other aspects these movements are of considerable importance.



FIG 108 —MOVEMENTS OF THUMB EXTENSION OF ALL THREE JOINTS

Carpo-Metacarpal Joint of Thumb—Owing to the shape of the articular surfaces a considerable range of movement is possible.



FIG 109 —MOVEMENTS OF THUMB ABDUCTION

(*a*) Flexion is the movement inwards of the first metacarpal across the palm (Fig. 107)

(*b*) Extension is the movement outwards in the same plane (Fig. 108).

Case IV.—D. Eight months previously, his horse stumbled and he was thrown, the greater part of the impact being borne by the left outstretched hand. A Colles's fracture resulted, which was set under an anæsthetic, a Carr's splint being applied and early massage and movements instituted. Sixteen days later, owing to the overturning of an oil lamp, the splint caught fire, and the forearm was burned. Owing to this accident, massage and movements were discontinued for three weeks. At the end of this period, this treatment was resumed, but it was found that marked pain and limitation of flexion of the wrist of an obstinate nature persisted Prolonged physical treatment having no beneficial effect, and as X-rays showed the fracture to be in good position, manipulation was performed under a general anæsthetic, and massage and movements started the same day.

Result—Almost complete movement obtained, and the pain, which had been obviously due to adhesions, disappeared

(D) THE THUMB AND FINGERS

The Thumb.

Surgical Anatomy (Fig. 103)—*Carpo-Metacarpal Joint.*—The saddle-shaped surface of the trapezium articulates with a corresponding surface of the base of the first metacarpal bone, the joint being surrounded by a capsular ligament.

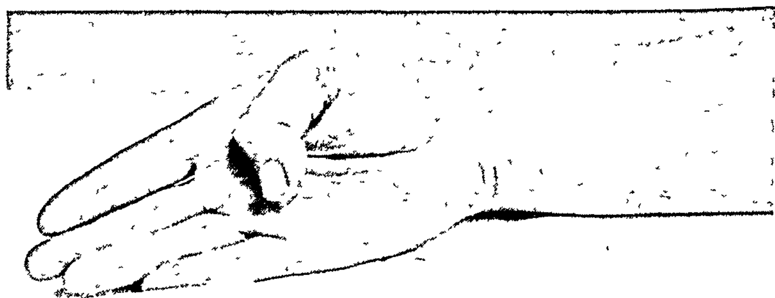


Fig 107—Movements of Thumb Flexion of all Three Joints—viz, Carpo-Metacarpal, Metacarpo-Phalangeal, and Interphalangeal

Metacarpo-Phalangeal Joint—Differs in no material degree from that described in the case of the fingers

Interphalangeal Joint—Similar to those occurring in the fingers.

Movements of the Thumb.—The movements of the thumb are really quite simple, but many fail to grasp the difference between such movements as abduction and extension of the thumb, or to realise the range of movement at the different joints It is hardly

The Articular Capsule is deficient dorsally, where its place is taken by the expanded extensor tendon. It is strengthened laterally and on the palmar surface by the lateral and palmar ligaments respectively. The former are attached to the sides of the metacarpal head and to the lateral aspect of the base of the proximal phalanx, while the latter, which is strong and fibro-cartilaginous, is attached firmly to the palmar surface of the base of the phalanx, but loosely to the neck of the corresponding metacarpal bone. Its palmar surface

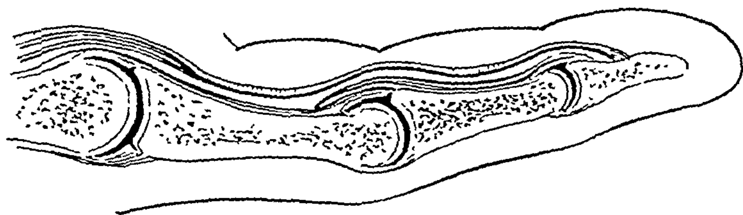


FIG 111—SECTION OF FINGER, SHOWING METACARPO-PHALANGEAL AND INTERPHALANGEAL JOINTS AND FLEXOR SYNOVIAL SHEATH

is in contact with the flexor tendons and their sheaths. Flexion at the metacarpo-phalangeal joints of the fingers is possible through 90 degrees (Fig. 112). Extension is possible through a similar range, and, in some cases, a few degrees of hyperextension are possible at these joints.

Abduction and adduction and circumduction are other movements that are possible at the metacarpo-phalangeal joints.

Interphalangeal Joints.—Hinge-joints. Capsular, collateral and

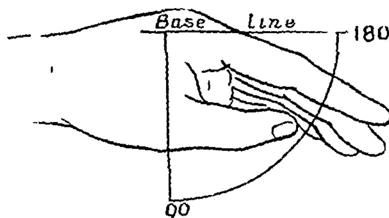


FIG 112—MOVEMENTS AT METACARPO-PHALANGEAL JOINTS

palmar ligaments are present as in the metacarpo-phalangeal joints. At each joint, flexion and extension are possible through 90 degrees.

Indications for Manipulation.—Stiffness of the thumb or fingers is liable to follow fracture of a metacarpal bone or phalanx, sprains, suppurative processes in the finger, especially when involving the tendon sheaths, chronic arthritis and prolonged immobility.

As in many other situations, a great many stiff fingers might have been prevented by more enlightened treatment. Prolonged im-

(*c*) Adduction is the movement of approximation of the first metacarpal towards that of the index finger

(*d*) Abduction is the movement away from the metacarpal bone of the index finger in the same plane (Fig. 109).

(*e*) Opposition is a combination of flexion, adduction, and internal rotation, in which the first metacarpal with its muscles, which constitute the ball of the thumb, is carried forwards and inwards, so that the thumb when slightly flexed can touch the tips of the slightly flexed fingers (Fig. 110)

(*f*) Circumduction is a combination of these movements.

Metacarpo-Phalangeal Joint of Thumb.—Flexion is only possible through about 45 degrees (Fig 107). Extension is possible through

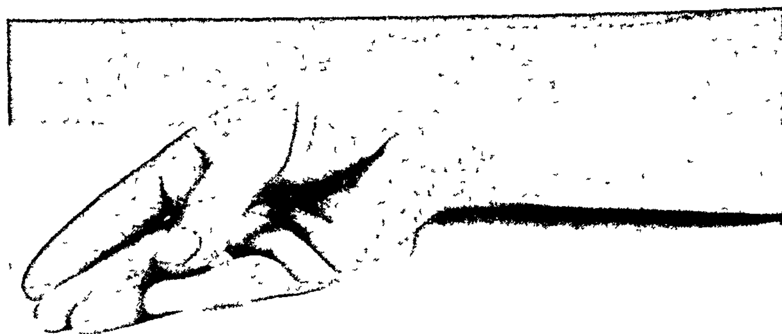


FIG 110—MOVEMENTS OF THUMB OPPOSITION

the same angle until the phalanx and metacarpal bone are in the same straight line (Fig 108).

Interphalangeal Joint of Thumb—Flexion through 90 degrees (Fig 107) Extension through similar angle until proximal and distal phalanges are in line (Fig 108)

The Fingers.

Surgical Anatomy (Fig 111)—*Carpo-Metacarpal and Inter-Metacarpal Joints*—Diarthrodial joints at which a certain amount of gliding movement is possible At the carpo-metacarpal joint of the little finger movement is considerable and some opposition is possible The bases of the four inner metacarpal bones are joined to the carpus and to each other by dorsal, palmar and interosseous ligaments

Metacarpo-Phalangeal Joints.—Condyloid joints in which the heads of the metacarpal bones articulate with the bases of the proximal phalanges.

case of the metacarpo-phalangeal joints, it is often assumed that the movements of flexion and extension are the only ones possible, and lateral movements of abduction and adduction and the movements of rotation and circumduction are apt to be forgotten.

It is also of fundamental importance to realise that the metacarpo-phalangeal and interphalangeal joints are not pure hinge-joints, but that during flexion and extension, a gliding movement of the base of the phalanx occurs.

In manipulation of the metacarpo-phalangeal and interphalangeal joints, the bones on the proximal and distal sides of the joint are firmly grasped between the index fingers and thumbs of the surgeon



FIG 113 —MANIPULATION OF INTERPHALANGEAL JOINT OF THUMB

and traction exerted (Fig. 113). In cases of somewhat dense adhesions, a firm steady pressure is exercised, whereas in the slighter types of adhesions more rapid movements are performed.

In performing flexion of the digits, the wrist should be simultaneously extended and lateral movements of the affected joint first performed. The next step is one of importance. During flexion, the phalanx must be made to glide forwards simultaneously by exercising pressure from behind forwards upon its base and by backward pressure upon the head of the bone below. If this manœuvre is omitted, the posterior and lateral ligaments are severely strained and increased stiffness of the joint naturally follows Finally, in the case of the metacarpo-phalangeal joints the

mobility of a joint in proximity to a fracture is responsible for many cases following fracture. A suppurative process can often be prevented from involving the tendon sheaths by early incision or by penicillin injections, and prolonged immobility of the fingers should be avoided. A good example of a most obstinate type of stiffness of the fingers from this cause is that seen after a neglected Colles's fracture. If immobility is practised for too long a period, stiffness of the wrist, carpal, metacarpo-phalangeal, and inter-phalangeal joints is apt to develop, which may prove very difficult to treat, and may require a series of manipulations. In the modern method of treating Colles's fracture, free movements of the fingers are encouraged from the first, and the movement of the flexor and extensor tendons as they pass over the immobilised wrist-joint largely prevents troublesome adhesion formation in the latter or in neighbouring tendons.

A slight displacement or subluxation at a carpo-metacarpal or inter-metacarpal joint often occurs, especially in boxers, and is apt to prove resistant to ordinary physical treatment. Localised tenderness may be elicited over the base of the affected metacarpal bone and dorsiflexion at the carpo-metacarpal joint is painful Such cases often respond brilliantly to manipulation.

The opinion is sometimes expressed that no benefit or even increased stiffness results from manipulating the stiffened thumb and fingers so often seen in the rheumatoid type of arthritis. However, provided the stiffness is not too pronounced, the disease is no longer active, and proper technique is employed, considerable benefit may result and the patient enabled to sew, write, and play a musical instrument. Most patients find these new possibilities a great boon, and such results will become more frequent when the fact is recognised that manipulative treatment is a highly specialised art and not a branch of "minor surgery." Benefit may result also from manipulation in the osteo-arthritic type of arthritis, as in that bugbear, arthritis of the carpo-metacarpal joint of the thumb (thumb-base arthritis)

Manipulative Technique.—In manipulating the thumb and fingers, it should be borne in mind that the heads of the metacarpal bones constitute an arch, and that a certain amount of movement is possible between the heads of adjacent metacarpal bones. Adhesions occasionally occur between the metacarpal heads, and interfere with the normal gliding movement. In breaking down these adhesions, the distal ends of each of the affected metacarpal bones should be grasped with the surgeon's thumb and forefinger, and smartly moved backwards and forwards upon each other In the

CHAPTER VIII

MANIPULATIVE TREATMENT: THE SPINE

CHRONIC backache, particularly of the lower back, is responsible for a great deal of suffering and disability in both sexes, but particularly in women. The stimulating work of Goldthwait and his school aroused fresh interest in the subject, and during recent years an enormous literature has developed, and differential diagnosis of the numerous conditions giving rise to backache has made rapid strides. It has been established that in some cases chronic backache and sciatic pain are due to a lesion of an intervertebral disc. This subject is evolving rapidly and is at present in a state of flux which scarcely seems to justify such sweeping statements as that injury of an intervertebral disc is the commonest cause of recurrent lower back and of sciatic pain; or that the symptoms hitherto attributed to chronic sacro-iliac and lumbo-sacral strain are in reality due to a lesion of the intervertebral disc between the 5th lumbar vertebra and the sacrum.

The definite establishment of disc lesions as a cause of chronic lower back and sciatic pain is of great importance, but it is necessary to leaven our enthusiasm with balanced scientific judgment and even common sense and to realise that disc lesions are among a very large number of causes of lower back and sciatic pain.

Routine X-ray examination has revealed the hitherto unsuspected frequency of congenital defects and abnormalities of the lumbo-sacral region. Brailsford found such deformities in no less than 26·4 per cent of a series of 3,000 cases * Although these deformities may exist without symptoms, subjection to unusual strains and stresses, as when the civilian from a sedentary occupation undergoes active service conditions, may cause symptoms of back strain. Some form of spinal support and the avoidance of over-exertion are often necessary in certain cases of chronic back strain, but for many years after Goldthwait's pioneer work, the same braces, corsets, and layers of strapping were applied to backs crippled by adhesions which demanded manipulation. The value of this measure was not generally recognised until recent times. For instance, Riches† has pointed out that in the orthopædic

* "Deformities of the Lumbo-Sacral Region of the Spine," by James F Brailsford, *Brit. Journ. Surg.*, April, 1929, p. 562.

† "End Results of Manipulation of the Back," by E W Riches, *Lancet*, May 3, 1930, vol. 1, p. 957.

movements of circumduction and abduction and adduction are carried out. When dense adhesions limiting flexion have been present, it is wise to bandage the finger or fingers in full flexion for twenty-four hours, and in cases of obstinate limitation of extension, similar temporary fixation in the extended position is desirable, either by a plaster slab or by the "banjo" type of splint, which permits the application of extension to the affected fingers. In all cases, re-education should be commenced immediately.

Occupational therapy is of great value in the after-treatment and rehabilitation of nearly all cases of stiffened fingers and particularly in those due to rheumatic forms of arthritis.

For the treatment of stiff and contracted fingers due to Dupuytren's contracture or to shortening of tendons, such as is seen in Volkmann's ischæmic contracture, a textbook of orthopædic surgery should be consulted.

curves also contributes to its strength and stability, for a vertical force is decomposed by the curves. The weakest mechanical points in the spine are where the comparatively rigid dorsal spine meets the more mobile lumbar portion, and at the junction of the latter with the pelvis.

The prolonged nature of the disablement following many spinal injuries is not difficult to understand, if we bear in mind the complexity of this region, and the number of its joints, ligaments, and muscles. The spinal cord traverses the neural canal of the vertebræ and important nerves emerge from it Consequently injuries of the spine are liable to be complicated by involvement of either the spinal cord itself or of the nerve roots, and are particularly liable to be followed by functional disorder.

Musculature of the Back.—The apparently complicated arrangement of the muscles of this region may be simplified by dividing them into separate layers. Of these, the first two belong to the upper extremity, including the shoulder girdle, and the fourth and fifth layers are more truly spinal.

First Layer—Trapezius, latissimus dorsi.

Second Layer.—Levator anguli scapulæ, rhomboids.

Third Layer.—Serratus posticus superior and inferior, splenius colli and capitis.

Fourth Layer: (*a*) *Sacral and Lumbar Regions.*—Erector spinæ. (*b*) *Thoracic Region*—Ilio-costalis, accessorius, longissimus dorsi, spinalis dorsi. (*c*) *Cervical Region*—Cervicalis ascendens, transversalis cervicis, trachelo-mastoid, complexus, biventer cervicis, spinalis colli

Fifth Layer.—Semispinalis dorsi, semispinalis colli, multifidus spinæ, rotatores spinæ, interspinales, extensor coccygis, intertransversales, rectus capitis posticus major and minor, superior and inferior oblique.

At first sight, such a recital of the different muscles is confusing. The problem may be simplified as follows:

Fourth Layer.—The "erector spinæ" has a strong tendinous origin from the iliac crest, the sacrum, and the lumbar spines, and divides into three muscular masses.

The outer—the sacro-lumbalis, with its prolongations, musculus accessorius and cervicalis ascendens—is attached to the **angles of the ribs.**

The middle—the longissimus dorsi, with its prolongations, transversalis colli and trachelo-mastoid—is attached to the **transverse processes of the vertebræ.**

department of the Middlesex Hospital, only ten back cases were manipulated in the quinquennium 1921-25, and no less than 103 in the quinquennium 1925-29. No doubt in the succeeding quinquennium a very great increase in these figures occurred, and this probably applies to most hospitals with orthopædic departments.

This contribution is of interest and value because it is one of the first attempts to approach the problem from the statistical aspect, the conclusion being that in more than 90 per cent. of cases of chronic back or sacro-iliac strain, manipulation is successful where there is evidence of definite exciting trauma These results coincide with the author's experience, and there can be no doubt that manipulative treatment can benefit many sufferers from one of the commonest and most difficult of disabilities.

It is interesting to observe that these high figures of successful results from manipulation were obtained during a period when lesions of the intervertebral disc were almost unknown If, therefore, these disc lesions are, as has been so confidently asserted, the commonest causes of chronic recurrent backache and of sciatic pain, the implication appears to be that disc lesions can be cured by manipulation. It is not impossible that this may sometimes happen, but the present state of our knowledge prevents a dogmatic opinion upon this point.

This chapter attempts to deal principally with the manipulative treatment of various chronic spinal disabilities, and space does not permit more than a cursory review of the pathology, symptomatology, and differential diagnosis of these disabilities, of which more detailed accounts are readily available

Surgical Anatomy.—A brief reference to some special points in the surgical anatomy of the spine, and to the normal range of movement possible in the different regions thereof, is an indispensable preliminary to any discussion of the conditions which are amenable to manipulation and of the technique involved For the general anatomy of this complicated region, the reader is referred to anatomical textbooks. A brief account will be given, in which we shall follow the observations of Lovett *

The spine is an elastic column which owes much of its strength to the fact that, although it consists of a number of vertebræ, the degree of movement between individual bones is slight, and yet the sum of movement considerable. The structure of the spine in a series of

* "Lateral Curvature of the Spine and Round Shoulders," by R W Lovett (H K Lewis and Co).

If we wish to ascertain the actual movements of the spine itself, some means must be taken of fixing the pelvis, and correction must be made for movement at the occipito-atlantal joint. Similarly, if exercises and manipulations are performed which are intended to act upon the spine alone, the pelvis should be fixed.

The actual movements may be divided into flexion, extension, and a complicated movement—lateral flexion + rotation. There is no such movement as a pure lateral flexion, for a certain amount of rotation inevitably accompanies this Similarly, rotation is always accompanied by a certain amount of lateral flexion. It is important to remember, however, that there is a variation in the degree of the rotatory and the lateral flexion elements respectively in the various regions of the spine. The nature of the movements is largely influenced by the shape and direction of the articular surfaces.

Flexion (Bending Forwards) —This movement is most marked in the lumbar region, and is possible until the normal forward convexity is practically obliterated. The movement is more marked, therefore, in the lower part of the lumbar region. In the cervical region, flexion can occur until the physiological curve is obliterated. The greatest degree of this movement of flexion occurs at the occipito-atlantal joint. In the dorsal region, forward movement is very slight, but the normal convexity backwards is slightly increased.

Extension (Bending Backwards).—This movement is most free in the lumbar and two lower dorsal vertebræ. Very little movement in this direction occurs in the remainder of the dorsal region, and in the neck the physiological curve can be increased slightly, the greater part of the movement occurring at the occipito-atlantal joint.

Lateral Flexion and Rotation—(a) Lateral Flexion Element.—As we have seen, this movement is always combined with a certain amount of rotation, but the element of lateral flexion is most marked in the lumbar zone. It is interesting and important to note that when the spine is flexed, lateral flexion occurs at a higher level in this region, and at a lower level when the spine is hyperextended.

(*b*) *Rotatory Element.*—In striking contrast to the lateral flexion element, the rotatory element is almost negligible in the lumbar region, but is most free in the dorsal and cervical region. It is not difficult to understand why this should be so, if the shape of the articular processes in the different zones be examined. Here, again, when the spine is flexed, rotation occurs at a higher level than in the erect position, but when the spine is hyperextended, at a lower level. Thus, by altering the degree of flexion or extension of the spine, the effect of rotation and lateral flexion can be brought to bear on successive spinal regions.

The inner—the spinalis dorsi, with its prolongations—is attached to the **spinous processes of the vertebræ.**

Fifth Layer.—The greater part of the muscles of this layer form a mass filling up the space between the transverse and spinous processes of the vertebræ, and the general direction of the fibres is oblique. The intertransversales pass between the transverse processes of adjacent vertebræ and the interspinales between the spinous processes. The semispinalis dorsi and colli, the multifidus spinæ, and the rotatores spinæ pass obliquely between the transverse processes and the vertebral spines. The more superficial bundles pass over several vertebræ, while the deeper bundles pass between adjacent vertebræ.

Lumbar Aponeurosis.—Many cases of prolonged disability are caused by injuries of this aponeurosis, or, rather, by injudicious treatment of such injuries by prolonged rest, until adhesions and scar-tissue have formed in it or its extensions It is a common site also for "rheumatism," which may be superimposed upon trauma

Ligaments.—These are exceedingly numerous, and, for their description, a textbook of anatomy should be studied Not only are there ligaments which stretch between the vertebral bodies (anterior and posterior common ligaments and intervertebral discs), but also ligaments connecting the articular processes, laminæ, spinous and transverse processes Further, there are ligaments connecting the heads of the ribs with the bodies of the vertebræ, and others connecting the necks and tubercles of the ribs with the transverse processes. In the upper cervical and lumbo-sacral regions, there are other important ligaments having special functions

Spinal Surgical Landmarks.—A few of the most important and essential of these are given

Root of Spine of Scapula —Interval between third and fourth dorsal spines

Inferior Angle of Scapula.—Interval between seventh and eighth dorsal spines.

Highest Point of Iliac Crest (*Interiliac Plane*) —Fourth lumbar spine

Posterior Superior Iliac Spine.—Second sacral spine.

Spinal Cord Ends —First lumbar spine (transpyloric plane).

Spinal Theca Ends.—Third sacral spine

Movements of the Spine.—The actual movements in the spine itself are really less than might at first sight be assumed. For instance, in full forward flexion a considerable amount of the apparent movement is pelvic, and takes place at the hip-joints, and some of the movement occurs between the skull and the spine.

but by scar-tissue in the region of the intervertebral foramina. By mobilisation under anæsthesia, this scar-tissue may be broken down or stretched, and benefit may result by relieving the pressure upon the nerve-roots. When definite osseous changes are present in the vertebræ, actual cure of the spinal arthritis *per se* is, of course, impossible. Manipulation of the spine is usually contra-indicated in spondylitis ankylopoietica.

The Injured Back and the Problem of Spinal Adhesions.—In the lumbar region, adhesions are extremely common, and may occur after some severe and sudden strain, or be a manifestation of rheumatism. If the strain occurred during flexion or rotation, both sides are usually involved, whereas if it occurred during lateral flexion, the symptoms may be unilateral. This condition is sometimes known as "traumatic lumbago," and, in its chronic forms, is a frequent cause of litigation and actions for compensation, and constitutes what is often a thorny and difficult problem. There is in many cases a combination of organic and genuinely functional elements, with exaggeration of symptoms; or such a mental attitude on the part of the patient that he seems unwilling or incapable of co-operating in treatment, or of ever admitting improvement. All of these factors may be present in varied proportions in different patients, or in the same patient at different times. These cases are among the most difficult in orthopædic surgery, and call for experience and surgical intuition in diagnosis, and patience and resource in treatment. In compensation cases, an attempt should be made to convince the patient that it is more to his moral and physical advantage to be cured than to exact the maximum amount of compensation for a disability which may, owing to his attitude, become a lifelong burden.

The whole picture is made more obscure by the fact that it is often difficult to distinguish between "traumatic lumbago" and what, for want of a better term, we may call "rheumatic lumbago." The latter may come on with almost startling suddenness; and not infrequently, even in severe cases, there is a history of a slight twist or some other minor form of injury which, in some mysterious and as yet little understood way, seems to light up an attack of this nature. Owing to the sudden onset of acute pain without known cause, the Germans call the condition *hexenschusz* ("witch's shot"). It is clear that no sharp line of demarcation can be drawn between the two varieties of lumbago, but it is only when there is a clear history of trauma that the symptoms should be attributed to an "accident" in the legal sense.

The picture is greatly complicated by the subjective factor.

Indications for Spinal Manipulation.—The most frequent indications for manipulation are those cases in which adhesions or scar-tissue in muscles, ligaments, or fasciæ have followed either toxic or infective conditions, or ligamentous or muscular injuries. These injuries naturally occur most frequently, but not exclusively, in the more movable cervical and lumbar regions. In the latter region, they are one of the causes of chronic lumbo-sacral strain. Some of these cases are associated with minor forms of osseous injury, such as fracture of a transverse, articular, or spinous process. The more severe forms of injury will not be considered here, as the field for subsequent manipulation in such cases is very limited. Other indications for manipulation include functional or hysterical conditions of the spine (including the so-called "railway spine"), except when the patient is claiming compensation, and therefore any improvement in his state does not accrue to his financial advantage. Unilateral dislocations, which are most common in the cervical region, are conditions which urgently demand manipulative replacement.

Another large group of cases in which manipulation of the back is of value includes chronic rheumatism, particularly involving the musculature and connective tissues, and giving rise to painful limitation of movement. Many chronic forms of "lumbago" are rheumatic in origin, and may recover rapidly after manipulation, often after years of ineffectual treatment. Rheumatic fibrositis in the lumbo-sacral region may simulate, and, indeed, be associated with, chronic strain, and may similarly benefit by manipulation.

The pathology and ætiology of fibrositis has not yet been placed upon a scientific basis. This is unfortunate, as it is one of the commonest afflictions of mankind, and is responsible for much incapacity. Davidson and Duthie have shown that of the 300,000 new cases of rheumatism occurring every year in Scotland, 75 per cent. are cases of fibrositis, and Copeman found that the incidence was very high in the B.E.F. in the Second World War.

The condition is variously known as lumbago, myalgia, muscular rheumatism, myositis and myofascitis, but in the present state of our knowledge it appears wiser to use the term fibrositis, originally given to it by Gowers.

Patients with spinal arthritis of the osteo-arthritic type, particularly in the cervical and lumbar regions, may benefit from manipulation. Referred pain in the form of occipital neuralgia or "sciatica" is common in such cases, and is due to pressure upon the nerve roots, not as a rule by bone, as is commonly supposed,

corset. This protects the injured disc but allows intensive re-education of the spinal muscles. Operation is usually advised when the protrusion has not reduced within three months, for recurrent cases and cases with persistent pain.

It is natural to ask, "How can one diagnose between a severe muscular sprain of the lumbar region and injury to an intervertebral disc?" The answer is that in any lower back injury associated with pain, muscular spasm and rigidity of the lumbar spine, the *possibility* of injury to the disc should be borne in mind. There is, however, no essential difference in the earlier treatment—viz, rest to the lumbar spine combined with early re-education of the spinal muscles. If, however, the symptoms drag on, and particularly if the clinical syndrome already described makes its appearance, the possibility of a disc lesion must be seriously considered.

The adoption of this plan of campaign will probably reduce the need for operations for removal of the injured disc to a minimum. Such operations in some clinics are already assuming heroic proportions and the immediate results in experienced hands are on the whole satisfactory. It is necessary, however, to be cautious in our interpretation of these results until sufficient time has elapsed. In many of the published results not more than one to three years have elapsed since operation. It may well be that the lesion of the disc is a kind of side-issue of a deep-seated strain of spinal ligaments and it is by no means certain in the cases in which no actual protrusion into the spinal canal occurs whether it is the major factor in causing symptoms.

Lumbo-Sacral Strain.—This condition may be of sudden onset following injury, or more gradual, when it is usually due to postural defects. The ætiology, symptoms, and diagnosis of this condition are discussed more fully in the next chapter. The patient complains of pain which is localised in the lumbo-sacral region, and there may be tenderness on deep pressure between the fifth lumbar and first sacral spines. There may be painful limitation of flexion of the lower lumbar spine, but this is often masked owing to the mobility of the other lumbar vertebræ. Manipulation may be of benefit in these cases, but not infrequently fails, owing to the difficulty of fixing the lumbar spine in such a manner that the movement is communicated to the lumbo-sacral joint. It is well worthy of trial in an intractable case.

In the cervical region, adhesions are particularly liable to follow falls upon the head in the hunting-field or in diving. In this region, also, we must be careful to distinguish between traumatic myositis following contusion or sprain, rheumatic myositis, which

Very often an unrelieved back pain precipitates a neurosis in the sufferer. It has been well said that a labourer whose back muscles are sore from hard work and troubled with insecurity may develop resentment against society or his employer and may use an injury to his back to gain attention and sympathy.*

Gratz† has studied the problem of backache, using a method of air injection followed by radiography. He maintains that the fascial spaces between the back muscles and surrounding important nerves are lined by a mesothelium and lubricated by lymph which permits a smooth gliding of the muscles upon one another. An injury or an attack of rheumatism may cause inflammation of the fascial layer or layers, with formation of adhesions and consequent obliteration of portions of the intermuscular fascial spaces Pain, muscular spasm, and limitation of movement result. He claims to have demonstrated the presence of these adhesions radiographically (fasciography) after injection of air. It has also been suggested that in the localised fibrositic areas which become fibrous nodules there is a local interference with the circulation, due to vaso-constriction from stimulation of sympathetic fibres (vaso-motor disequilibrium hypothesis of Leriche).

Lesions of the Intervertebral Disc.—In some cases of traumatic "lumbago" the injury is more complex and is associated with a lesion of an intervertebral disc This should be suspected if the lumbar spasm is intense and if there is continuous pain at first which is increased by movement and by coughing.

Before herniation of the nucleus pulposus, there is an increase in the lumbar curve and flexion of the lumbar spine is prevented by intense muscular spasm Some hyperextension and lateral flexion are, however, possible The increase in the lumbar curve assists repair of the annulus of the disc, and as the posterior borders of the adjacent vertebræ are approximated, a barrier is formed to any protrusion of the nucleus pulposus If the spine is immobilised in this position, the rent in the annulus may be repaired by scar-tissue. If the nucleus pulposus is extruded, sciatic pain usually becomes a prominent feature and the lumbar spine becomes flattened or even kyphotic, although a little forward flexion may be possible; extension is prevented by the protrusion Lateral deviation is often present This position of the spine is the ideal one to assist the protrusion to retrace its steps. Both types of case usually respond well to immobilisation of the spine by means of a plaster jacket or

* *Lancet*, Leading Article, October 6, 1945, p. 437

† Gratz, C M, *Amer Jour Roentgen*, 1936, **35**, 750; and *Arch Surg*, 1937, **4**, 461

lateral bending, or rotation, or combinations of these. Tenderness is usually present at the site of the adhesions, and is often associated with localised muscle spasm. For instance, when present in one lumbar region, the erector spinæ of that side is often in a state of spasm, causing scoliosis of the lumbar spine with its concavity towards the affected side. In cases of rheumatic adhesions, a history of previous attacks of rheumatism, absence of a traumatic cause, clinical or X-ray manifestations of rheumatism, and some suggestive ætiological factor will point to the true cause.

Many different conditions may cause backache, and as in some of these manipulative treatment may be futile or dangerous, no spinal manipulation should be performed without a clear idea of the condition present and the object to be achieved. Accurate diagnosis is therefore of the greatest importance, and requires a patient and exhaustive examination in every case, including thorough investigation of the medical history. Radiological examination should never be omitted and medical, gynæcological, and psychological colleagues may render valuable aid in difficult back problems. It is helpful to take the history and carry out the clinical examination in a routine manner and according to a definite scheme. Without such a system it is surprisingly easy to overlook some important factor.

History.—The patient's complaints concerning the back, their site, duration, mode of onset, and any factors which increase the symptoms, must be noted. Sometimes the pain is localised, but often it is referred to other regions. Sacro-iliac pain, for instance, is often referred to the back of the thigh, and lumbo-sacral pain to the outer side of the leg and foot. In women, enquiry should be made about the menstrual periods and previous pregnancies. When there is a history of injury to the back, the date and nature of this must be accurately stated.

The question of occupational strain is important, and it should always be remembered that general debility, worry, overwork, frustrations, and an unhappy love affair or incompatibility between husband and wife are frequent causes of backache in both sexes.

A loaded colon occurring in chronic constipation and growths in the colon, rectum, or prostate may give rise to lower-back pain. Affections of the kidney are occasionally responsible for backache. Pain in the back associated with or following an operation for malignant growth must always be viewed with grave suspicion.

It is of the greatest importance to rule out tuberculous disease of the spine by careful attention to the history, to the signs and symptoms, and to X-ray examination.

may occur very suddenly without definite history of injury, and the rarer conditions of unilateral dislocation or subluxation. In all, the position usually assumed is one of "wry-neck," the head being laterally flexed towards the affected side and rotated to the opposite side.

Prevention of Adhesions in the Spine.—In the treatment of injuries, of slight or moderate degree, affecting the ligaments or musculature of the spine, and of rheumatic affections of the same structures, experience teaches that those cases in which judicious rest to the affected region is combined with heat, massage and muscular re-education from the first, respond incomparably better than those in which treatment by prolonged and uninterrupted rest is adopted. If the treatment is skilfully performed, the patient almost invariably expresses a sense of great relief. In the unlikely event of such simple methods of physical treatment causing an increase of pain and disability they should, of course, be discontinued. It is inconceivable that measures which relieve pain and make the patient more comfortable can be harmful, yet it is surprising how seldom these measures are intelligently employed from the first, and how often they are rendered impossible by a rigid cuirass of strapping. It seems clear that if early massage and muscular re-education were employed from the first we should see a great reduction in chronic disabling conditions of the back.

In some cases of acute myofascitis affecting the back muscles an injection of novocain or some other cocaine preparation into the site of maximum pain and tenderness will often make such movements comparatively painless, and there is evidence that such injections followed by active movements of the affected region may result in a dramatic cure of an attack of " lumbago " or diminish its duration and intensity.

Diagnosis.—The following classification of backache, though not exhaustive, includes most of the commoner conditions

1. Referred from other regions
2. Associated with static or postural errors.
3. Congenital abnormalities
4. Traumatic, including prolapsed disc and spondylolisthesis.
5. Rheumatic, including arthritis, fibrositis, or myofascitis.
6. Specific diseases such as T.B.
7. Neoplasms, innocent or malignant, primary or secondary.
8. Combined cases

The most characteristic symptoms of adhesions are pain and limitation of some particular movement, either of flexion, extension,

erector spinæ, and consequently in myofascial lesions the pain will remain."

(2) *Lateral and Ventral Recumbency.*—Pain when lying on the side of the lesion suggests a sacro-iliac lesion. Test spinal movements in these positions; also extension of thighs Investigate for areas of tenderness in back or along nerve trunks.

5. *X-ray Examination* —This should never be omitted, and should



FIG 114 —MANIPULATION OF CERVICAL SPINE

include lateral or oblique as well as the routine antero-posterior view of the affected region of the spine In conditions affecting the pelvis stereoscopic radiographs are invaluable. X-ray examination may, with special technical methods, be of assistance in the diagnosis of such causes of backache as tumours of the spinal cord and prolapse of an intervertebral disc.

6. Special laboratory tests may be indicated, such as Wassermann's, Kahn's, the sedimentation rate of the blood-corpuscles,

Examination of the Patient.—The following scheme is based upon that of Professor R B. Osgood

1. *General Examination*—Heart, lungs, blood-pressure, tonsils, teeth, etc.

2. *Examination Standing.*—Note posture, particularly any increase of normal spinal curves, abnormal deviations of spine, contour of abdomen, and abnormalities or differences in length of the lower extremities, including pes planus. Movements of the spine, both active and passive, and presence of any generalised or local pain or muscular spasm. If any movement is painful, the patient is asked to indicate the site with the tip of the forefinger. Shape of chest and chest expansion.

3. *Examination Sitting.*—The movements of the spine are repeated. In lumbo-sacral cases forward flexion is limited, but in sacro-iliac this movement is comparatively free because the pelvis is supported and the hamstrings relaxed. Reflexes are tested and disturbances of sensation and motion in the limbs noted.

4. *Examination Lying*—(1) *On Back*—Tilting of pelvis as shown by alteration in level of anterior superior spines and undue prominence of great trochanter. Measure length of lower limbs and examine for wasting of thighs and calves. General inspection of joints for swelling, tenderness, or limitation of movement. Flexion of thighs on pelvis with knees bent; in lumbo-sacral lesions this is usually painful, whereas in sacro-iliac this is not the case, because the pelvis moves more as a whole.

Flexion of the thighs with the knees straight (Goldthwait's sign) is helpful in distinguishing between low spinal and sacro-iliac lesions..

Straight-leg-raising, or Lasègue's test, is often of value but is positive in a number of conditions, including sciatica, sacro-iliac strain and prolapsed disc in lumbar region. When tension on the hamstrings is relieved by flexing the knee, the pain will only persist if it originates in the hip-joint. In all other conditions, both intra-spinal lesions and extra-spinal, such as gluteal fibrositis and sacro-iliac strain, pain will be relieved Burns and Young* have elaborated this test as follows "With the leg raised and the knee flexed just sufficient to relieve the pain, the head is flexed on the chest. The pain, if due to intraspinal lesions or lesions of the erector spinæ or its fascia, will return. Further flexion of the knee will relieve the tension on the meninges so that the pain from an intraspinal lesion will go, but relaxing the hamstrings will have no effect upon the

* B H Burns and R H Young, "Protrusion of Intervertebral Disk," *The Lancet*, October 6, 1945, p. 424

Dorsal Region.—Many methods of manipulating the dorsal spine have been described, but those recommended are as follows:

Method 1.—This is most useful for applying rotation and side-bending to the dorsal spine (Fig. 115). The patient sits upon a low stool with the hands clasped behind the neck. The surgeon stands



FIG. 116.—METHOD OF APPLYING EXTENSION TO UPPER PART OF DORSAL SPINE

behind or a little to one side and, stretching across the front of the patient, grasps the patient's arm with one hand and with the other applies pressure to the posterior aspect of the affected region of the back in the region of the angles of the ribs. A powerful leverage is thus obtained and movements of flexion, extension, side-bending

tests for tuberculosis, and various investigations of blood, urine, fæces, and spinal fluid.

Manipulative Technique—*Cervical Region* (Fig. 114).—The patient's head projects beyond the end of the operating table, the surgeon grasps the occipital region with one hand, and places the other hand under the patient's chin. Very gently, carefully avoiding undue force, and simultaneously applying traction, the movements of



FIG 115—METHOD OF APPLYING ROTATION AND SIDE-BENDING TO DORSAL SPINE

flexion, extension, lateral bending, and rotation are performed. The principle of immediate re-educational exercises is followed, as after any spinal manipulation, and, as we have already emphasised in connection with the articulations of the limbs, should never be neglected if we desire a rapid and complete recovery. Manipulation of the neck performed thus may have a valuable effect in cases of occipital neuralgia and headache.

Lumbar Region.—The patient lies supine upon a low couch or mattress placed upon the floor. The operator fully and forcibly flexes the thighs to their full extent (Fig. 118). Then, keeping the thighs in the fully flexed position with one hand, he places the other hand beneath the patient's pelvis and flexes, rotates and bends the pelvis laterally, thus producing corresponding movements at the lumbo-sacral and lumbar joints (Figs. 119 and 120). Next the patient is placed in the side-lying position and the " pelvic twist " performed in order to produce maximum rotation of the lumbar vertebræ. This manœuvre, which somewhat resembles a form of manipulation for the sacro-iliac joint, described in the next chapter, should be

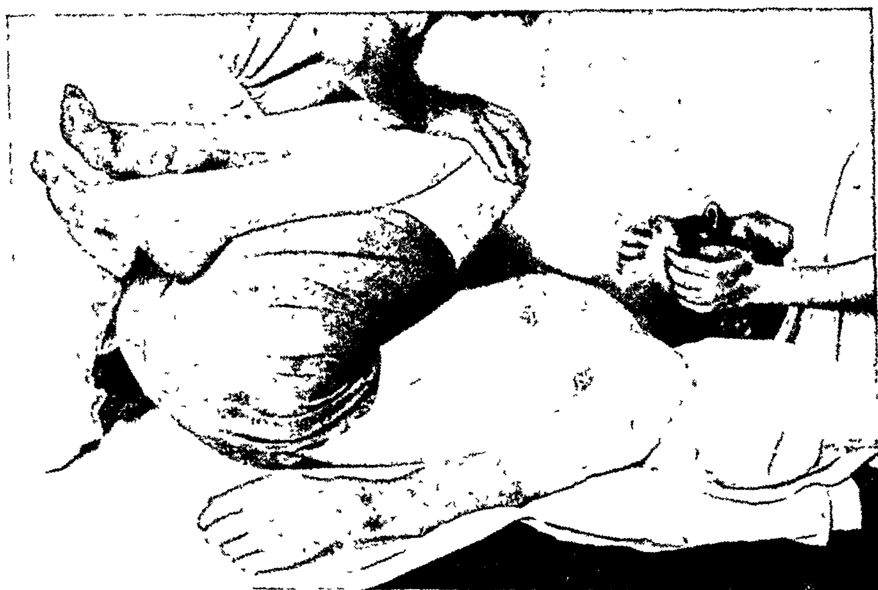


FIG. 118—MANIPULATION OF LUMBAR SPINE. FIRST MOVEMENT. COMMENCEMENT OF FLEXION

performed with the patient lying on both right and left sides (Fig. 125). Finally, the patient is placed in the prone position and the surgeon extends the lumbar spine by lifting the thighs backward, in the manner shown in the figure, while he presses firmly upon an area in the lumbar region immediately above that to which it is desired to apply the maximum degree of extension. At the same time his assistant (not shown in the figure) applies traction to the patient's legs (Fig. 121).

After-Treatment.—A common cause of a disappointing result after manipulation of the spine lies in the fact that the after-treatment has been faulty. At the risk of reiteration, it is necessary to emphasise

and rotation carried out. Side-bending and rotation to the opposite side are carried out by the surgeon grasping the opposite elbow or arm of the patient with his other hand and reversing the process.

Method 2.—This is a useful method of applying extension to the



FIG 117—METHOD OF APPLYING EXTENSION TO LOWER PART OF DORSAL SPINE

dorsal spine (Figs. 116 and 117). The patient sits upon a low stool with the hands clasped behind the head and the surgeon stands behind. The surgeon grips the patient's arms near the axillæ. Next he places his knee just below the affected region of the dorsal spine, which is protected by a pad, and simultaneously applies traction and extension.

pain must always be borne in mind. If such exists, special exercises are prescribed to improve the tone of the abdominal muscles, supplemented, if necessary, by the wearing of a supporting belt or corset.

Functional Disabilities of the Spine.—In this group, manipulation is performed for its psychological effect. The patient has, in all probability, been told by many people that the spine is normal, whereas we must remember that a functional condition is very real to the patient. It is in this type of case that the bone-setter's "bone out of place," which he proceeds to "replace" by manip-

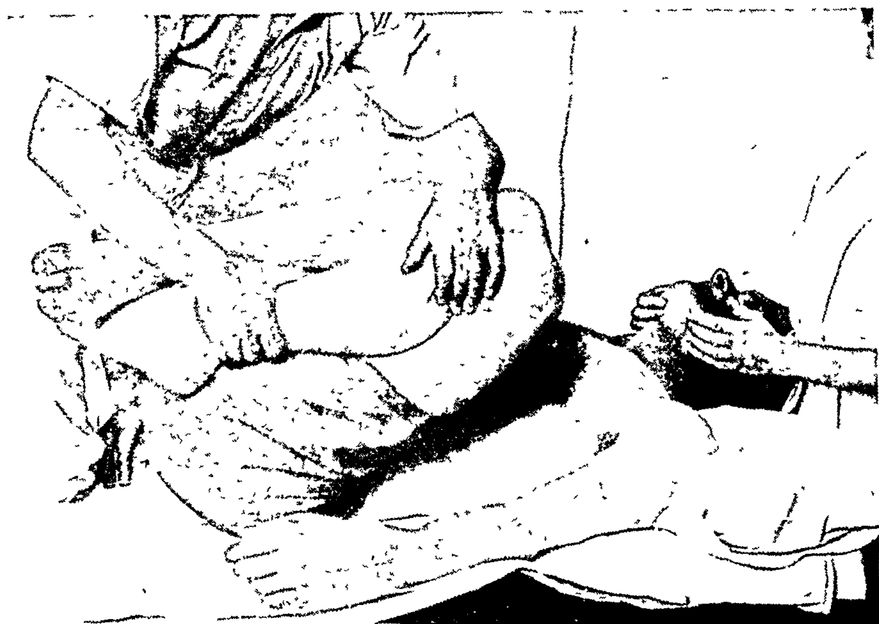


FIG 120—MANIPULATION OF LUMBAR SPINE THIRD MOVEMENT. ROTATION OF PELVIS AND LUMBAR SPINE

(For Fourth Movement, see Fig 125)

ulation, has a psychological effect which we cannot ignore. Whatever explanation we give, we must convince the patient that we are going to cure the condition by manipulation. This should be carried out preferably under pentothal anæsthesia, and re-education and suggestion follow immediately, not only by the surgeon, but by everyone with whom the patient comes into contact. This after-treatment must not, however, be of such a nature as again to concentrate the patient's mind upon the back. Re-education by games or suitable occupation in new and healthy surroundings and far from the pernicious influence of over-sympathetic relations or friends,

the importance of early re-educational spinal exercises, concentrating, although not exclusively, on those movements which were restricted before manipulation *

The patient should have a hot bath a few hours after the manipulation, after which exercises are performed under the supervision of the physiotherapist. These may be usefully preceded by infra-red and massage. Such treatment should be continued until the



FIG 119—MANIPULATION OF LUMBAR SPINE SECOND MOVEMENT.
The operator by lifting the pelvis imparts further flexion to lumbar and lower dorsal spine

musculature of the back has recovered its tone and all movements are full and free. When defective posture is present, other factors must be considered, and in particular the effect of a weak and sagging abdominal wall in causing or aggravating chronic low-back

* A valuable exercise when lumbar lordosis is present is to teach the patient to straighten the lumbar spine against a wall or other flat surface by combined action of the glutei and abdominal muscles, which corrects the abnormal tilting of the sacrum and the accompanying lordosis

by rotation backward on the affected side, usually succeeds, provided this treatment is carried out at the earliest possible moment.

After-Treatment.—In cases of subluxation or unilateral dislocation unassociated with cord symptoms, immediate massage and gentle movements may be instituted. Where, however, fracture of an articular process has coexisted, a short period of immobilisation in a well-fitting plaster-of-paris case or moulded poroplastic support is necessary.

Illustrative Cases of Manipulation of the Spine.

Case I.—The patient, aged 44, complained of acute pain in the lower part of the back which had been present for three weeks. He stated that he had been subject to frequent similar attacks of "lumbago" all his life, and for many years had walked badly, with the trunk inclined towards the left side. Beyond an attack of typhoid fever when a boy, general health had been good.

On Examination.—Scoliotic curve of moderate degree involving lower dorsal and lumbar regions, with convexity towards right side. Definite spasm of both erector spinæ muscles in lumbar region, more pronounced on the left side. Forward flexion in lumbar region markedly restricted and painful, also lateral flexion towards the right side. Musculature of back ill-developed and weak. On lying, marked pain was caused by full flexion of the thighs, and Kernig's sign was present on both sides. X-ray showed no abnormality beyond slight scoliosis. Patient had never been able to lead a very active life owing to the back condition.

Diagnosis.—Adhesions in left lumbar and in lumbo-sacral regions causing recurrent attacks of "lumbago" and associated with defective spinal mechanics, weak musculature, and probably a certain functional element—*i.e.*, the typical spinal syndrome and vicious circle. Manipulation was performed with gratifying results. Pain was immediately and greatly relieved, and after a few weeks of massage and remedial exercises, completely disappeared, and there has been no recurrence of lumbago. He has an erect bearing, and has been able to take up an active athletic life.

Case II.—Miss W., aged 21. Four years previously the patient was walking along a pole in the gymnasium, when she slipped and fell astride. She immediately experienced severe pain in the perineum and coccygeal region, but there was never any evidence of any gross lesion of the pelvis, spine, or of the pelvic viscera, either clinically or radiographically. A very severe form of traumatic neurasthenia followed, associated with chronic invalidism. The principal complaints were of lack of energy, so that it was impossible to play games, although previously the patient had been most active and keen, and of almost constant pain in the

often lurking in the background and holding up progress, should be the aim.

Unilateral Dislocations of Cervical Vertebræ.—These accidents, although not very common, occur with sufficient frequency to demand a knowledge of their reduction They may occur after some comparatively trivial accident. The head is held in a distinctive manner, being laterally inclined towards the affected side and rotated to the opposite side, and movements of the neck are painful and restricted. The inferior articular process of the upper vertebra usually becomes displaced in front of the superior articular process



FIG 121 —MANIPULATION OF LUMBAR SPINE FIFTH MOVEMENT. EXTENSION COMBINED WITH TRACTION.

of the lower vertebra. In some cases there is detachment of an articular process. A less severe type of injury may be encountered, in which the articular process of the displaced vertebra rests upon the edge of the corresponding process of the vertebra below. There is thus *no actual interlocking, and in this type of lesion the patient's* head may be laterally inclined towards the opposite side and only slightly rotated Good stereoscopic X-rays, which should never be omitted in any doubtful case of injury to the neck, will reveal the type of lesion present.

Reduction.—Traction followed by rotation backwards on the side of dislocation, or lateral flexion towards the uninjured side followed

neoplasms of the pelvic organs or of the spine or pelvis, Paget's disease of the latter sites, prolapsed intervertebral disc, tuberculous and non-tuberculous arthritis of the spine, sacro-iliac and hip-joints, and injuries affecting the same regions, with or without the presence of adhesions.

The necessity of a thorough investigation of every case of sciatica is thus obvious, and particularly before any manipulative treatment is undertaken. When sciatic pain has been preceded by an operation for malignant disease, a secondary growth in the lumbar spine should always be suspected.

In addition to the primary and secondary forms of sciatica, there exists a very large group of cases in which the cause cannot be ascertained. This group was formerly labelled "essential" or "idiopathic" sciatica Much valuable work has been done upon this subject, and it has been found that many of the cases in this group are in fact due to various forms of pressure, not only in the lumbo-sacral region of the spinal column and in the pelvis, but also in the course of the nerve trunk. Goldthwait was one of the first to draw serious attention to the importance of various mechanical defects of the spine and pelvis in the ætiology of sciatica. The work of Sicard* and of his colleagues and of Putti† has also shed valuable light upon this problem and has shown that many cases of "idiopathic" or "essential" sciatica are due to vertebral arthritis Sicard and Forestier pointed out that many cases of sciatic pain are due to pressure upon that segment of nerve which lies between the anterior and posterior spinal roots and the plexus and which traverses the intervertebral foramen. To this part of the nerve Sicard has given the name "funiculus," and to the syndrome resulting from pressure at this site, the term "funiculitis"

Anatomically, an intervertebral foramen in the lumbar region is bounded as follows Above and below by the intervertebral notch—in front by portions of the posterior surfaces of the bodies of adjacent vertebræ and of the intervening disc, behind by the articulation between the inferior articular process of the vertebra above and the superior articular process of the vertebra below Bearing these facts in mind, it is obvious that if the joints between the articular processes are involved in an arthritic process or if they are subjected to injury such as sprain or fracture, pressure is liable to occur upon the adjacent funiculus, with resulting sciatic pain

The intervertebral foramina between the fourth and fifth lumbar

* Sicard, "Traité de Path Méd et Thérap Appl," tome 2.

† Putti, V, "New Conceptions in the Pathogenesis of Sciatic Pain," *Lancet*, 1927, i 53

lower part of the spine, and that the back frequently "gave way" She had consulted many distinguished surgeons, both in this country and on the Continent. Her back and pelvis had also been manipulated nearly fifty times by an osteopath

On Examination—Vague tenderness was found over the lower part of the spine and over the pelvis generally. The back moved well, and there was no evidence clinically or radiographically of any gross displacement The mentality was introspective and apprehensive A diagnosis of hysterical spine was made The following plan of campaign was formulated The patient was assured that no serious organic disease or lesion existed, but that some condition was present which could be completely put right by manipulation followed by a course of exercises Manipulation of the spine was accordingly performed under gas and oxygen anæsthesia, and the principles of after-treatment, to which we have already referred, religiously carried out

Seven weeks later she wrote "I am riding, swimming, and playing tennis every day, and it is simply marvellous, and we didn't believe it could ever be. It will just make all the difference to the rest of my life and to other people's too" The cure has been maintained

Manipulation in Sciatica and Sciatic Scoliosis.

The term "sciatica" should be used to indicate pain in the distribution of the sciatic nerve, and no more constitutes a scientific diagnosis than such other vague terms as "anæmia" or "synovitis" The presence of the symptom of sciatic pain necessitates an exhaustive clinical investigation, which should include good stereoscopic radiographs of the lumbar spine and of the pelvis and hip-joints It is unfortunate that radiographs showing the lateral and oblique aspects of the lumbar spine and lumbo-sacral region are often omitted, as these aspects may give valuable information when the antero-posterior shows no obvious abnormality.

Varieties of Sciatic Pain.—The term "primary" sciatica is applied to those cases in which neuritis of the sciatic nerve exists Inflammation which affects the nerve sheath and the interstitial connective-tissue fibres may occur in the course of various toxæmias such as diabetes, alcoholism, syphilis and lead-poisoning, or may be due to the presence of some pyogenic focus. In such cases of primary sciatica, tenderness on direct pressure over some portion of the nerve trunk and disappearance of the ankle-jerk are often present True primary sciatica is far less frequently encountered than the types described below.

Secondary sciatica is due to pressure upon or irritation of the nerve trunk or its roots, or of any of its branches in any part of their course It may, therefore, be due to many causes, such as

patient to flex the thigh on the affected side to the normal angle of 90 degrees when the knee is simultaneously extended. Attempts to perform this movement passively also bring about intense spasm of the hamstrings. In chronic cases, there may be marked wasting of the buttock, thigh, and leg, and diminution or loss of the ankle-jerk.

In cases of sciatic scoliosis following injury the possibility of a lesion of a lumbar intervertebral disc must always be borne in mind.

Toxic Fibrositis or Myofascitis.—It has become increasingly clear in recent years that many cases of sciatic pain with scoliosis are due to irritation or constriction of the sciatic nerve by adhesions, not in the region of the intervertebral foramen as described above, but in some part of its extrapelvic course. It will be remembered that, after leaving the pelvis between the pyriformis and superior gemellus, the nerve is intimately related to and lies between various muscular planes Normally these muscles are covered by smooth layers of connective tissue and between them movement is smooth and frictionless In many cases of so-called muscular rheumatism, toxic fibrositis or myofascitis, adhesions form in and around these muscles which may cause sciatic pain by direct pressure upon the nerve or one of its branches. In the latter case, points of extreme sensitiveness can often be discovered, pressure upon which may cause generalised sciatic pain ("trigger points"). Such adhesions may form in the lumbar or gluteal regions or in the thigh, and have been demonstrated by radiography after preliminary injection of oxygen into the fascial spaces (see p. 216). Sometimes a firm contraction of the gluteal fascia and of the fascia over the tensor fasciæ femoris may occur, giving rise to abduction deformity of the hip in addition to the sciatic syndrome.

During recent years, as already mentioned, other important causes of sciatic pain have been differentiated clearly and definitely. One of the most interesting of these is prolapse of the nucleus pulposus of the intervertebral disc (see p 216).

Manipulative Treatment.—It is obvious that the causes of the sciatic syndrome are many and that treatment will obviously depend upon the type of case and the stage of disease. X-ray examination is an indispensable preliminary. To regard manipulation as a panacea for all cases is to court disaster. As a general rule manipulation should be avoided in the acute and early stages, and at this stage rest and purely medical treatment directed towards the alleviation of pain, and the elimination of toxic processes, if present, combined with some mild physical treatment, are indicated. As soon as the acute symptoms have begun to subside, gentle movements, both active and passive, may be carefully

vertebræ and between the fifth lumbar and first sacral vertebræ are the smallest in the lumbo-sacral series, and the fourth and fifth lumbar funiculi are the thickest and also have the longest intervertebral course. When it is remembered that the fourth and fifth lumbar roots (especially the fifth) constitute important elements of the sciatic nerve, and when it is also remembered that the fourth and fifth lumbar vertebræ are subjected to great strains and stresses, it will be seen that this region is particularly predisposed to the conditions that may give rise to sciatic pain Congenital abnormalities such as various degrees of sacralisation of the fifth lumbar vertebra are also very common in the lumbo-sacral region and predispose to injury and to the onset of arthritis, with resulting pressure upon the fifth lumbar root.

Each joint between the articular processes has its synovial membrane and is surrounded by a capsule, and the movements are of a gliding and rotatory nature. Inflammation of these joints is accompanied by the phenomena which we have previously described in connection with the larger articulations, and there is no reason to doubt that there is the same tendency to adhesion formation In the earlier and more acute stages of sciatic pain, the funiculus is doubtless subjected to pressure by the swelling of the adjacent joint, and its dural sheath is involved in the inflammatory process. In the later and chronic stages, the funiculus may become constricted by adhesions, and sciatic pain may be more or less constant and aggravated by movement of the affected region of the spine The movements of the spinal articulations may be similarly impeded.

Sciatic Scoliosis.—This term is given to a syndrome frequently associated with sciatic pain. Rigidity of the musculature in the lumbar region is one of the most constant features in this type of sciatic pain, and is at first of a reflex or protective nature As has already been noted, reflex spasm of the muscles acting upon the joint is a frequent accompaniment of arthritis, and this spasm of the lumbar muscles frequently exists with arthritis of the lumbar articulations Many patients, moreover, state that one or more attacks of "lumbago" preceded the onset of sciatic pain

Most frequently the spasm is of such a nature that a "total" contralateral scoliosis is produced, so that the whole spine inclines away from the affected side This attitude has the effect of opening up the intervertebral foramina on the affected side and relieves pressure upon the funiculus Occasionally the scoliosis is homolateral or may alternate. In addition to scoliosis, there is general rigidity of the lumbar region, so that flexion of the lower spine is markedly restricted An important sign is the inability of the

regulated, force flexed in the sagittal plane until it forms an angle of slightly less than 90 degrees with the trunk. In stretching of the left sciatic nerve the position of the surgeon's hands is reversed

This manœuvre is of value not only in breaking down or stretching adhesions around the sciatic nerve in the gluteal region and thigh, but in the treatment of scar-tissue in the hamstring group of thigh muscles and in the intermuscular connective-tissue planes It should be remembered that the normal range of flexion of the thigh



FIG 122.—STRETCHING OF SCIATIC NERVE AND MUSCLES AT BACK OF RIGHT THIGH

with the knee extended is to an angle of 90 degrees with the trunk, and that an attempt to force this movement in an exaggerated way, as is sometimes recommended, is not only unnecessary, but may damage the hamstring muscles or do serious damage to the sciatic nerve itself

Stretching of Ilio-Tibial Band.

Ober maintains that contraction of the ilio-tibial band may cause chronic low back-ache and even sciatic pain, and it is obvious that

commenced, and if no increase of pain results, they should be continued. Such movements are of great value in preventing the formation of adhesions and the resulting chronic disability.

It is in the more chronic stages associated with the syndrome of lumbar pain and stiffness, scoliosis and painful limitation of flexion of the hip with the knee extended* that manipulation is frequently of the greatest value When the seat of the trouble is in the lumbar or lumbo-sacral region, it is important to remember that mere stretching of the sciatic nerve trunk alone is usually ineffectual and that the affected region of the spine must be manipulated. Omission of this important manœuvre, or failure to perform it adequately, probably accounts for many failures of manipulative treatment for sciatic pain.

Some authorities pin their faith on immobilisation of the lumbar spine in this type of sciatic pain. Such temporary immobilisation is desirable if it is due to a ruptured disc, and in the cases under consideration such immobilisation may relieve pain while the spinal support is worn by minimising pressure upon the funiculus as it lies in the intervertebral foramen. However, as has been frequently pointed out in this book, this relief from pain is deceptive, as the prolonged rest causes the insidious formation of adhesions around the funiculus which, unless suitably treated, may cause permanent disability. In such cases, many patients are condemned to the wearing of a spinal support permanently and unnecessarily Needless to say, these remarks apply to cases in which the radiograph shows slight or moderate arthritic changes When the changes are advanced, the spinal jacket may be ultimately necessary, but as a considerable degree of improvement may sometimes follow manipulation, it seems only reasonable to give this a preliminary trial.

Manipulative Technique—*Stretching of the Sciatic Nerve* (Fig. 122).—This is an operation for which perfect muscular relaxation is necessary and necessitates some form of anæsthesia. Pentothal is of considerable value, supplemented, if necessary, by gas and oxygen. The patient lies supine upon a low couch and the operator stands upon the affected side while his assistant steadies the opposite lower extremity and keeps it flat upon the couch The surgeon grasps the affected lower extremity in the manner shown in Fig 122, which represents stretching of the right sciatic nerve The patient's foot lies in the crook of the surgeon's right elbow, and the patient's leg and thigh are firmly grasped in the manner indicated. In this way the affected lower extremity is converted into a rigid column. The thigh is then firmly and with gradually increasing, but carefully

* Straight leg-raising test also known as Lasègue's sign

CHAPTER IX

MANIPULATIVE TREATMENT: THE SACRO-ILIAC JOINT

Surgical Anatomy.*—Marked differences exist in the descriptions of this important joint in the standard textbooks of anatomy. It is a somewhat difficult joint to dissect or demonstrate satisfactorily, with the result that it is often overlooked

Opinions differ whether a subluxation can or cannot take place at this joint, and it has often seemed that in many cases that crucial fact, the anatomy of the joint, has been overlooked It has been maintained by some, who consider that sacro-iliac strain or subluxation does not occur, that the joint is a synchondrosis. Cunningham's "Anatomy" refers to the sacro-iliac joint as a diarthrosis formed between the contiguous auricular surfaces of the sacrum and ilium, and states that each of the surfaces is more or less completely clothed by hyaline articular cartilage Reference is made to the capillary nature of the joint interval which may be crossed by fibrous bands, and to the imperfect and rudimentary nature of the articular cavity

Morris speaks of the joint as a diarthrosis (subdivision, arthrodia), but refers to an ear-shaped cartilaginous plate which unites the bones firmly and is accurately applied to the auricular surfaces of the sacrum and ilium. It is about 2 millimetres thick in the centre, but becomes thinner towards the edges. Though closely adherent to the bones, it tears away from one entirely, or from both partially, on the application of violence It is really one mass, and is only occasionally formed of two plates with a synovial cavity between them. A more or less extensive synovial cavity is occasionally present within the fibro-cartilage, and also a synovial lining to the ligaments passing in front and behind the articulation

Gray's "Anatomy" classifies the joint among the amphiarthroses, but otherwise the description given closely corresponds with that given by Morris.

Testut sums up the matter by stating that the articulation resembles an amphiarthrosis by the limited amount of movement possible, and by the presence of a layer of fibro-cartilage between the articulating surfaces, but that it resembles a diarthrosis in having a joint cavity and a synovial membrane. He adopts Sappey's classification of the joint as a diarthro-amphiarthrosis.

Sappey has minutely described the cartilaginous coverings of the

* This aspect is simplified if reference be made to the bones of the pelvis and to the articulated skeleton.

contraction of the band may cause a painful limitation of adduction of the thigh. The manœuvre that Ober recommends for eliciting this contraction of the ilio-tibial band is as follows:

The patient lies on the unaffected side with the hip and knee of that side fully flexed

The examiner stands behind the patient and, assuming that the patient is lying on the left side, places his left hand upon the right trochanteric region.

The surgeon's right hand grasps the right leg of the patient just below the knee and abducts the right thigh fully and then hyperextends it while abducted

Next, the surgeon allows the thigh to drop towards the table. Ober claims that in the presence of a tight ilio-tibial band the thigh remains abducted, even in the anæsthetised patient. He recommends for this condition that the ilio-tibial band be transversely divided by operation.

It has become recognised of recent years that the ilio-tibial band plays a very important part in the maintenance of the stability of the lower extremity, and if this structure is contracted or can be incriminated as a definite cause of lower back or sciatic pain, thorough stretching under anæsthesia, which may be repeated if necessary, should be performed before undertaking division of such an important structure.

Manipulation of the Lumbar and Lumbo-Sacral Region—The technique of this manipulation in cases of sciatic pain of vertebral origin differs in no important respect from that described on pages 225 and 246, to which reference may be made. In practice, the manipulation of the lumbar and lumbo-sacral regions is best preceded by stretching the sciatic nerve trunk and hamstring group by the method just described, and, as already pointed out, a combination of the two methods should always be carried out in manipulation for sciatica and the sciatic syndrome.

Articular Surfaces.—The articular surfaces of sacrum and ilium are somewhat L-shaped, the anterior limb being somewhat shorter and wider than the inferior limb. The articular surface of the sacrum is slightly concave from side to side, the concavity being most marked at the angle between the two limbs. Here the junction between the posterior and upper borders forms a prominent lip which fits into a corresponding depression behind the convex articular surface of the ilium. This constitutes an important interlocking mechanism around which rotation takes place. If, moreover, a coronal section be made through this portion of the pelvis, it will be seen that this part of the sacrum constitutes a wedge, the truncated apex of which is directed downwards.

Movements.—A slight but quite definite amount of movement, both gliding and rotatory, occurs at this joint. Gliding may be upwards and downwards, or forwards and backwards. But the most important movement is of a rotatory nature and takes place around the interlocking mechanism of the middle segment described above In this rotatory movement, either sacrum or ilium may be the principal factor. In the case of the former, assuming that the force is acting from above upon the sacrum, the anterior and upper part of the sacrum is tilted downwards and forwards, thus diminishing the antero-posterior diameter of the pelvic inlet, and the lower and posterior part is displaced upwards and backwards, increasing the antero-posterior diameter of the pelvic outlet.

Forward pressure upon the lower end of the sacrum will have the opposite effect The movement of the upper segment is principally limited by the strong interosseous and posterior sacro-iliac ligaments; that of the lower segment by the great and small sacro-iliac ligaments.

This rotation of the sacrum may cause symptoms of bilateral torsion strain. In the case of the ilium, it should be remembered that important muscles are attached to the os innominatum. For instance, a sudden powerful action of the rectus femoris, attached to the anterior superior iliac spine, may rotate the iliac element downwards and forwards, causing an anterior torsion sprain (Fig. 123). Similarly, sudden powerful action of the hamstring group attached to the ischial tuberosity may rotate the ischial element forwards and the iliac element backwards, causing a backward torsion sprain.

Affections of the Sacro-Iliac Joint.

The joint is subject to many of the injuries and diseases which are encountered in other articulations. Owing, however, to its deep-seated position, the indirect nature of many of the signs and symp-

articular surfaces He states that they have not the pure white and glistening surface of articular cartilage; that the sacral surface is smooth, but that the iliac is rough and tuberculated; and that while the cartilage of the iliac surface is fibro-cartilage, that which clothes the sacrum consists of two layers—a deep of hyaline cartilage and a more superficial of fibro-cartilage.

Brooke has recently re-examined the anatomical problem, his observations being based upon examination of two hundred sacro-iliac joints obtained from dissecting and post-mortem rooms.

He concludes that the old description of the joint as an amphiarthrosis was the description of a pathological change. The normal joint is of the diarthrodial type, and in all probability takes part in movements backwards and forwards of the lumbar spine Male and female joints are quite distinct in function and mobility, for whereas the former is built for strength, aided by the presence of extra- and intra-articular tubercles, the latter is altered to meet the requirements of parturition and an increase in mobility. This it does by movements in a transverse direction as well as the rotatory movement described by Walcheren The joint cavity itself is well defined, with a continuous fringe of synovial membrane attached to the margins of the articular cartilage

The author's own investigations support these views.

Ligaments.—The articular areas of the sacrum and ilium are connected by the following ligaments

Anterior sacro-iliac
Short posterior sacro-iliac
Long posterior sacro-iliac
Interosseous sacro-iliac.

The anterior sacro-iliac ligament is of moderate density and is attached to the anterior and inferior or pelvic margins of the articular surfaces The short and long posterior sacro-iliac ligaments need no special notice, but the interosseous ligament is of great importance. It is called by some anatomists "the deep portion of the posterior sacro-iliac ligament," and the ligament, which is very strong, passes between the rough areas above and behind the auricular surfaces of ilium and sacrum. Its function is an important one. It is to be remembered that the sacrum differs from the keystone of an arch in that its ventral surface is wider than the dorsal. There is thus a tendency in the erect position for the superimposed body weight to drive the sacrum downwards and forwards into the pelvis. This tendency is counteracted by the interosseous ligament.

normal forward convexity of the lumbar spine is diminished, leading to flattening of this region. This type also leads to serious alterations in the spinal mechanism. Pregnancy and prolonged illness are important predisposing causes of chronic bilateral sacro-iliac strain or subluxation. In the former, relaxation of the joint ligaments is physiological, and in some cases the normal stability is never completely regained. After prolonged illness the muscular tone may be seriously diminished, and the normal support of the spine withheld, so that undue strain is placed upon ligaments, relaxation occurs, and the spinal mechanism is profoundly altered.

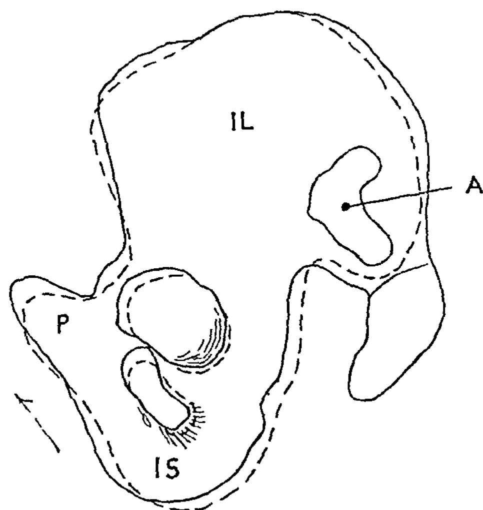


FIG 123 —DIAGRAMMATIC REPRESENTATION OF ANTERIOR TORSION STRAIN OF LEFT SACRO-ILIAC JOINT

A, axis of rotation in sacro-iliac joint, IL, ilium, IS, ischium, P, pubes The dotted line represents in a deliberately exaggerated manner the rotation of the os innominatum in anterior torsion strain The arrow shows the direction of the force to be applied to the ischial tuberosity in correcting the subluxation

Unilateral Cases.—Acute sacro-iliac strain is usually brought about by force applied to the ilium, often by a sudden and violent muscular contraction; the displacement at the sacro-iliac joint when present being usually a slight rotatory displacement of the ilium upon the sacrum. In anterior torsion strain (Fig. 123) there is a slight forward rotation of the upper or iliac portion of the innominate bone upon the sacrum associated with backward rotation of the lower or ischial portion. In posterior torsion strain there is a backward rotation of the upper or iliac portion associated with forward rotation of the ischial or lower portion. This type is often due to a sudden and violent contraction of the hamstrings.

toms, and its intermediate position between the hip-joint and spine, diagnosis sometimes presents special difficulties. For this reason, tuberculous disease of the joint is often overlooked until it has reached a somewhat advanced stage. The importance of radiographic examination of all cases of pain in the sacro-iliac region is therefore obvious, although the X-rays are often difficult to interpret and may not show suspicious changes until well-developed disease is present. We are here concerned with those conditions of the sacro-iliac joint which can be benefited or cured by manipulation, and shall, therefore, confine our remarks mainly to the conditions known as sacro-iliac strain and subluxation

It is important to remember, however, that many of the signs and symptoms that will be described are seen in affections of the sacro-iliac joint and its ligaments, due to non-tuberculous infection and toxæmia, in which manipulation may also be of considerable value. In some instances, the symptoms may be due to strain and super-added infection or toxæmia in variable proportions, as we have seen to occur in many other joints.

Mechanism of Sacro-Iliac and Lumbo-Sacral Strain.

Bilateral Cases.—It has already been noted that excessive downward and forward rotation of the sacrum is normally prevented by the strong interosseous posterior sacro-iliac ligaments. When, for any reason, such rotation has become extreme or excessive it is clear —particularly in bilateral cases—that great strain is also exercised at the lumbo-sacral articulation, particularly at the articulations between the articular processes of the fifth lumbar vertebra and the first sacral vertebra. In this way, the articular surfaces and even the spinous processes are forced into firm and close apposition, leading to pain and limitation of movement. Posture, instead of being maintained by muscle tone, becomes largely dependent upon ligaments which become unduly stretched, and upon excessive strain upon articular surfaces. In an attempt to restore the normal equilibrium, compensatory lordosis of the lumbar spine takes place, and profound alterations and disturbances result in the spinal mechanism. The rotation of the sacrum is the primary factor in a train of consequences which give rise to a complicated syndrome, in which, owing to muscular wasting, a vicious circle can often be traced.

In other cases, particularly after prolonged lying on the back, the opposite state of affairs exists, and the upper end of the sacrum rotates backwards and the lower end forwards. In such cases, the

Movements.

Flexion of Spine.—The movements of the lower back that are restricted or painful in the standing, sitting, and lying positions respectively may be tabulated as follows, in which table comparison is also made with the corresponding movements in lumbo-sacral strain:

Lumbo-Sacral Strain

STANDING	SITTING	LYING
Muscle spasm keeps lumbo-sacral region rigid and forward bending takes place at hips and in upper lumbar and dorsal regions	Same limitation of forward bending occurs as in flexion standing	Passive lumbar flexion by flexing hips on pelvis painful and restricted as on flexion, standing and sitting

Sacro-Iliac Strain

STANDING	SITTING	LYING
The patient bends forward first by flexing lumbar spine, then by tilting pelvis until hamstrings become taut Next he either stops or bends further by flexing knee and relaxing hamstrings	Forward flexion usually free, as, owing to relaxation of hamstrings, no leverage is transmitted to the pelvis	Pelvis moves as a whole owing to absence of leverage Forward flexion usually free and painless except in very acute cases

Straight Leg Raising.—If the lower extremity be raised from the couch to the vertical with the knee fully extended, the hamstring muscles become taut, and unilateral tension is brought to bear upon the pelvis. In sacro-iliac cases this test is painful, but is also productive of pain in certain other conditions such as sciatica (Lasègue's sign).

A useful point in differential diagnosis is that in sciatica, if the patient's ankle is dorsiflexed while the lower extremity is in the above position, increased pain results. Such increased pain is unusual in cases of uncomplicated sacro-iliac strain

As the patient inclines the trunk away from the affected side, a functional scoliotic curve of the lumbar region develops with its convexity towards the affected side. Compensatory tilting of the pelvis occurs with apparent shortening of the lower extremity on the side of the lesion. Wasting of the muscles of buttock and thigh is frequently present. Occasionally there is pain on compressing the iliac bones together, and a difference in the relative positions of the posterior superior iliac spines.

Subluxation.—It is probable that the irregularity of the articular surfaces of the sacro-iliac joint predisposes to subluxation. It is easy to see that a slight rotatory displacement of the innominate bone upon the sacrum might cause acute pain and disability and might become fixed owing to the irregularity of the articular surfaces Moreover, such a slight displacement might occur without radiographic evidence.

To sum up, chronic strain may give rise to relaxation of the joint ligaments, which may or may not be associated with subluxation. Acute strain may occur alone, may be associated with subluxation, or may be followed by symptoms of chronic strain as above.

Pain.—The nerve supply of the sacro-iliac joint is derived anteriorly from the lumbo-sacral cord (L. 4 and L. 5), posteriorly from the first and second sacral nerves, and below from the superior gluteal nerve. The obturator nerve may, in some cases, contribute to the innervation of the joint. Owing to these innervations, pain may be referred to the posterior aspect of the thigh or to almost any part of the leg Usually, however, the leg pain is felt on the antero-lateral and posterior aspect, and on the outer aspect of the ankle Pain may also be felt which follows the course of the superior gluteal nerve from the sacro-sciatic notch outwards towards the tensor fasciæ femoris When the obturator nerve takes part in the innervation of the joint, pain may also be experienced upon the inner aspect of the thigh.

Effect of Position upon Pain.

Standing.—The patient bears most weight upon the leg of the unaffected side, and keeps the leg on the affected side slightly flexed, as this relaxes the hamstrings and lessens weight transmission through the affected joint.

Sitting.—The patient sits upon the unaffected buttock, thus avoiding weight transmission and pressure upon the sciatic nerve on the affected side.

Lying.—The patient lies either upon the back or upon the unaffected side.

Walking.—This aggravates the pain, and, in going upstairs, the patient progresses one stair at a time, dragging the limb of the affected side after him. The patient tends to walk with the body inclined away from the affected side.

Tenderness is present at a characteristic and very localised area, usually about a centimetre in diameter, over the posterior sacro-iliac ligament between the posterior superior and posterior inferior iliac spines

Treatment.

In chronic strain, the condition is primarily due to weakened musculature, and our aim must be to correct this by a judicious combination of support and muscular re-education. All faulty attitudes, both standing and sitting, must be corrected.

It must be remembered that although mechanical supports are useful as a temporary measure, they do not correct the primary muscular weakness, and a successful issue depends largely upon building up the spinal musculature by special exercises.



FIG 124.—CORRECTION OF BACKWARD TORSION STRAIN OF RIGHT SACRO-ILIAC JOINT. METHOD I.

When these measures have been given a fair but unsuccessful trial, and when subluxation is suspected, both from X-ray and the obstinate nature of the symptoms, manipulation often proves a successful procedure. In those cases associated with abnormal laxity of the joint, manipulation is contra-indicated, and if a combination of mechanical support by a corset or special belt and of muscular re-education fails to relieve the pain and disability, it will probably be necessary to bring about ankylosis of the joint by means of a bone graft.

Some acute forms of strain may recover with such local measures

Although in lesions of the sacro-iliac joints there is almost invariably limitation of certain movements, there is in some cases hypermobility, particularly when, as the result of long-continued strain, the joints have become relaxed.

This may be detected by hyperextension of the thighs, or if the crests of the ilia are grasped with the two hands, with the thumbs resting on the sacrum, and the patient raises first one knee and then the other, the motion of the sacro-iliac joint may be felt. In such cases, the patient often complains of a feeling of marked instability. These signs and symptoms are more often encountered in the bilateral cases following pregnancy

Sacro-iliac strain, both acute and chronic, and conditions of relaxation are recognised clinical entities.

Although acute unilateral subluxation is anatomically possible, and one is often led to suspect it strongly, the diagnosis cannot at present be made with any degree of certainty.

However, the sudden onset of acute symptoms associated with the sacro-iliac syndrome after some particular movement and their equally sudden relief by manipulation, often accompanied by an audible "snap," is strongly suggestive of a minimal shift of the articular surfaces.

Radiographic Appearances.

We here approach a problem concerning which there is considerable difference of opinion. Some, although admitting the existence of sacro-iliac strain and subluxation as clinical entities, deny that the latter condition is recognisable radiographically. Those holding the opposite view point out that as the displacement is not vertical but rotatory, a stereoscopic radiograph of the whole pelvis is necessary for its demonstration, and also to demonstrate disalignment of the symphysis pubis which is said to be diagnostic It must be remembered, however, that minor abnormalities of the pelvis are frequently discovered accidentally and give rise to no symptoms, moreover, a slight difference in the angle of projection of the X-rays on the two sides may give rise to an appearance simulating a displacement. It is clear, therefore, that a diagnosis of sacro-iliac subluxation cannot be made from radiography alone, although sometimes good stereoscopic radiographs of the whole pelvis may furnish suggestive evidence.

In chronic cases of relaxation, proliferative changes may be seen at the joint margins, particularly below, or increased density along the joint line, indicating that osteo-arthritic changes have supervened.

which in this case is uppermost, is flexed to a right angle and projects over the side of the couch. The operator with his left hand then forces the patient's right shoulder backwards into contact with the couch, and with his right hand applies pressure to the upper and back part of the patient's right iliac bone in a downwards and forwards direction, thus rotating it forwards. This movement involves also a rotation of the lumbar and lower dorsal vertebræ in the opposite direction.

In bilateral forms, the respective manœuvres must be carried out on both sides.

A somewhat similar technique may be employed to produce rotatory manipulation of the lumbar spine, except that the forward thrust of the operator's hand is applied at a higher level.

After-Treatment.—In the more acute forms, relief is usually immediate. In a small percentage of cases, further manipulative treatment may be needed owing to recurrent attacks, and, rarely, repeated attacks may necessitate arthrodesis of the sacro-iliac joint. In the chronic forms associated with relaxation and weakened musculature, temporary support in the form of a sacro-iliac belt or corset should be combined with muscular re-education. which is the main essential in preventing a recurrence of symptoms.

as rest, radiant heat, and muscular re-education Others prove extremely resistant to every form of local treatment, and in such, treatment by manipulation is a method of proved value which, particularly in unilateral cases, is accompanied by a high percentage of successful results

Manipulative Technique.—General anæsthesia is advisable, and intravenous pentothal is particularly valuable

The technique differs according to the type of strain present.

Forward Torsion Strain—This is treated by forced flexion of the thigh with the knee extended as in Fig. 122 This manœuvre, by



FIG 125—THE "PELVIC TWIST" TO CORRECT BACKWARD TORSION STRAIN OF RIGHT SACRO-ILIAC JOINT

tension upon the hamstrings, pulls the ischial tuberosity forwards and the ilium rotates backwards into position.

Backward Torsion Strain—Method 1—The patient is placed in the lateral lying position with the affected side uppermost and with the hip and knee-joints nearest the couch fullyflexed to fix the lumbar spine. The uppermost thigh is then hyperextended. This manipulation, by pulling upon the rectus femoris and Y-shaped ligament of the hip-joint, rotates the ilium forwards into position (Fig. 124).

Method 2.—The "pelvic twist." This manœuvre is shown in Fig. 125 as applied to backward torsion strain of the right sacro-iliac joint. The patient lies in such a position that the upper part of the trunk is in the supine position, and the lower part, including the pelvis, in the side-lying position. The right thigh,

placed upon the history and the radiographic appearances taken in conjunction with the other clinical signs previously mentioned. The surgeon must never yield to pressure on the part of patient or relatives to perform manipulation of such a joint. The tubercle bacilli which have become imprisoned by connective tissue may be set free by the forced movement, and give rise to an acute inflammatory condition of the joint, which may progress rapidly. Abscesses may form, burst, and give rise to chronic discharging sinuses, which become secondarily infected. Amputation may become necessary owing to complete disorganisation of the joint and to prevent the patient steadily going downhill from pain, secondary infection, or lardaceous disease.

Furthermore, the forced movement may not only stir up the latent organisms in the joint into activity, but, in children particularly, may disperse them throughout the body by the circulation, giving rise to generalised miliary tuberculosis.

Fracture of an Adjacent Bone, Dislocation, or Damage to Bloodvessels, Nerves, or Other Important Structures.

In ankylosis of a joint the bones in the region of the articular ends undergo a greater or lesser degree of disuse atrophy. In attempting to restore movement in such conditions there is a grave risk, unless care be taken, of causing a fracture of the adjacent bone.* The risk of fracture of the surgical neck of the humerus or of dislocation of the humeral head in manipulating a stiff shoulder-joint has already been mentioned. The same risk is present in unreduced dislocations of long standing in which peri-articular contracture has occurred; in such, a degree of force, which is insufficient to remove the obstruction to movement caused by such peri-articular

* Although great care should obviously be taken to avoid a fracture during manipulation, such an event need not necessarily cause the surgeon sleepless nights as it may in the long run be to the patient's advantage. The author has fractured a bone on two occasions only in twenty-five years of manipulative work. The first case was one of manipulation of a very stiff shoulder with marked adduction and limitation of abduction. A fracture of the surgical neck of the humerus occurred. This was set appropriately so that the range of abduction was greatly increased and the final result was similar to that of a planned osteotomy of the surgical neck. The second case was one of obstinate limitation of extension of the knee by some 15 degrees. Here a supracondylar fracture had the effect of completely correcting the limitation of extension, and the final result was satisfactory. These cases are mentioned, not to minimise the need for great care to avoid fracture, but to show that such an event need not always cause the surgeon undue depression of spirits.

CHAPTER X

DANGERS OF MANIPULATION IN UNSUITABLE CASES

In the preceding chapters an attempt has been made to point out some of the dangers of misapplied manipulation. The subject is of such importance that it will be the aim of this chapter to summarise the principal risks and dangers which, needless to say, are particularly applicable to unqualified practice.

It should be pointed out, at the outset, that not only may there be danger in the manipulations themselves, but that even when more futile than dangerous, this form of treatment may prevent a patient from seeking proper medical advice until, as in cases of malignant disease, the favourable time for treatment has irretrievably passed.

Tuberculous Arthritis.—This subject has been discussed in Chapter IV, and the importance of X-ray examination has already been stressed. The dangers of manipulation in this form of arthritis are, however, so great, that, at the expense of a certain amount of repetition, it is considered advisable to emphasise again a few special points.

In many types the symptoms are acute, the pain is severe, and it must be obvious, even to the most ignorant, that manipulation of any kind is absolutely contra-indicated. It is well known, however, to all experienced practitioners that tuberculous disease of a joint may be of a very chronic nature, with slight swelling of the joint, particularly after exercise, a little limitation of movement in certain directions, and localised tenderness. At first sight, such a case may appear to be one of chronic synovitis due to some mechanical cause, or may be considered to be one of the non-tuberculous forms of arthritis. It is only after the most thorough and exhaustive examination by a trained and qualified practitioner or, better still, by a team of colleagues working in unison that an accurate diagnosis is possible.

There have been many disastrous results of manipulation by bone-setters in such cases. Differential diagnosis has already been touched upon (*vide* Chapter IV), but there are two signs in particular that should make the practitioner suspicious. These are (*a*) persistently raised temperature over the joint, (*b*) marked muscular wasting. There is, again, a large and important group of stiff joints due to old tuberculous disease in which signs of active disease are no longer present. In these, the clinical sign of raised local temperature will not be present, and principal reliance must be

Pain and stiffness of the back in a patient who has had an operation for malignant growth should always arouse suspicions of secondary spinal metastasis.

Myositis Ossificans.

In this condition, following an injury of, or in the vicinity of, a joint, particularly the elbow-joint in children, there is a formation of new bone in muscle, ligament, tendon, or other connective-tissue structures, which gives characteristic radiographic appearances. The condition is probably due to the liberation of osteoblasts or bone-forming cells from beneath the torn periosteum, which escape into the surrounding parts, where they proliferate. In children it is stated to be more common after dislocation of the elbow-joint than after fracture in the region of the elbow, so that the possibility of osseous metaplasia of connective-tissue cells cannot be ruled out of court. It is characteristic of this condition that massage, passive movements, and manipulations cause increased pain, swelling, and muscular spasm, and increase the rate of formation of new bone. All such treatment, therefore, is absolutely contra-indicated. If a little painless active movement persists it may be very carefully encouraged, and is a valuable sign of commencing recovery. It should steadily increase, provided misguided efforts at forced movement are avoided. There is no objection, however, if the joint has become fixed in a bad position, to moving it gently under anæsthesia into that position which experience has shown to be the best should ankylosis prove inevitable. Manipulations or passive movements are also contra-indicated in most acute inflammations of joints, although gentle active movements, if at all possible, should be encouraged, and are valuable in preventing subsequent ankylosis.

contracture, may suffice to cause fracture. When there is risk of fracture owing to the density of adhesions, manipulation is of doubtful value, and attended with the least satisfactory results. Neither is it fair to judge the value of manipulation by the somewhat disappointing results seen in this type of case.

The reaction when such dense adhesions are broken down is so severe that the tendency to restiffening of the joint is very marked. The choice in these cases lies between—

(*a*) Leaving well alone.

(*b*) A series of manipulations, the manipulator resting content with a few degrees of increased range by each, and consolidating the ground gained before launching a further attack.

(*c*) Surgical operations such as excisions, osteotomies, tenotomies or capsulotomies.

(*d*) Orthopædic apparatus.

These remarks apply also to the question of injury to blood-vessels and nerves during manipulation. As a general rule, such accidents are usually due to the use of an undue degree of force, to the use of manipulation where open operation is indicated, or to an attempt to do too much at one manipulation.

Neoplasms of the Joints and Spine.

Pain and stiffness of a joint or of the spine may be due to a malignant neoplasm. In the museum of the Royal College of Surgeons of England are at least two specimens of such a condition involving the knee-joint obtained from limbs which, previous to amputation, had been subjected to manipulation by bone-setters.

In the museum of St. Bartholomew's Hospital is a specimen (No 471*b*) of myeloid sarcoma of the head of the tibia, with the following description

"Removed by amputation from a man aged 36 years Four years previously he began to suffer pain in the left knee-joint, and was advised to wear an elastic knee-cap. This he did for six months Towards the end of that period the knee began to enlarge and grow slowly bigger. Twenty months before the operation he consulted a bone-setter, who diagnosed displacement of a cartilage and conducted a course of fourteen manipulations without benefit to the patient"

Many cases are on record of malignant growth of the spinal column which have been subjected to manipulation by bone-setters with disastrous results. Such tragedies may be avoided by careful clinical examination and by insisting on X-ray examination prior to manipulation.

of movement obtained by manipulation, and thus prevent the renewed formation of adhesions, and to restore the wasted muscles and the strength and usefulness of the limb, it is of first-rate importance to follow every manipulation by a well-planned course

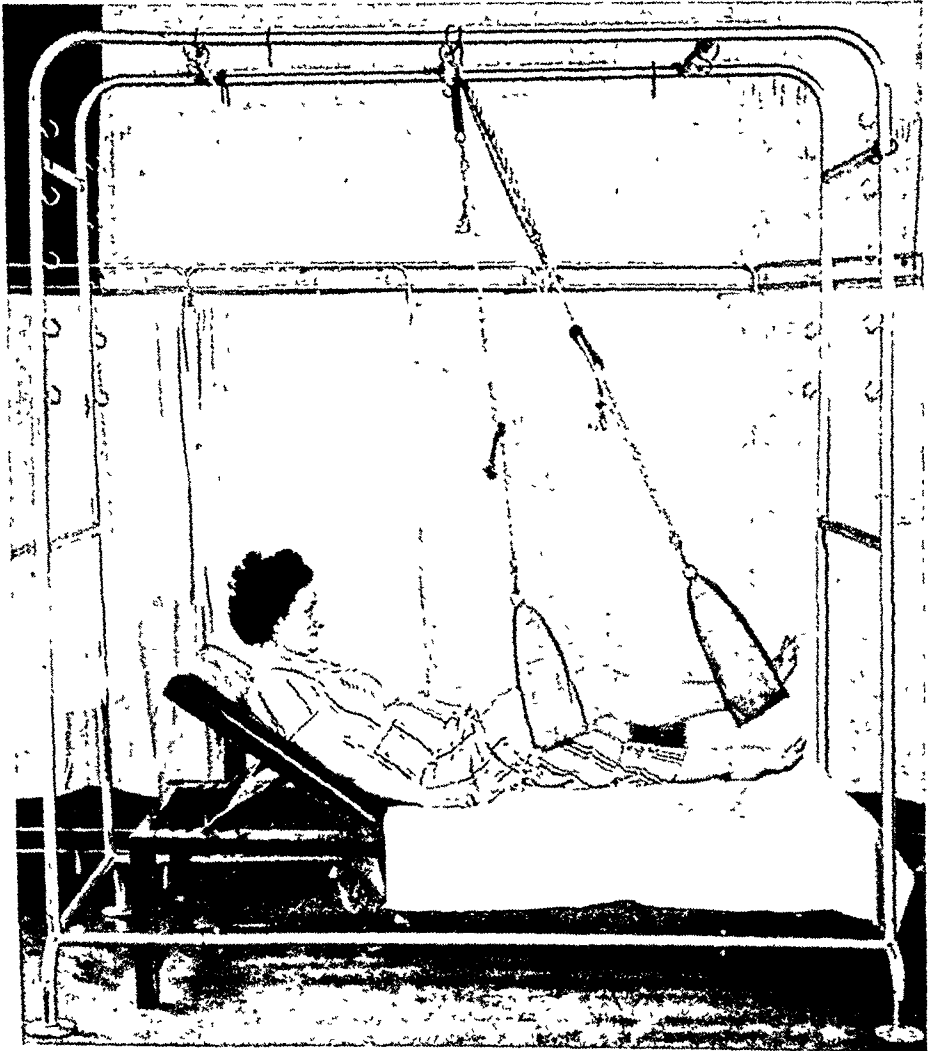


FIG 126--GUTHRIE-SMITH SUSPENSION APPARATUS
In use in mobilisation and re-education of the musculature of the right knee.

of muscular exercises. The principles of muscular re-education are beyond the scope of this work, but a few special points may be noted. As a general rule re-education by exercises—*i.e.*, those performed by the patient—are far more valuable than passive movements carried out for the patient by another person, or by mechanical

CHAPTER XI

NOTES ON AFTER-TREATMENT

SOME of the principal points in after-treatment have, as far as possible, been discussed under individual headings. In this chapter an attempt will be made to summarise briefly the main principles. For further details, special textbooks and monographs on physical treatment should be studied.

Exercises and Muscular Re-education.—After manipulation, **the joint must be voluntarily moved through the increased range at the earliest possible moment.** When the adhesions are slight, the movements through the increased range must be performed immediately or within a few hours of recovery from the anæsthetic. In minor cases it is often advisable to hold the limb in the previously impossible position, so that when the patient recovers from the effects of the anæsthetic he is personally convinced of his new power. In cases of moderate degree, the after-treatment is similar; but it may be two or three days before the patient can actively perform the full range of movement obtained by manipulation. In cases associated with the presence of more dense adhesions, and in which it has been possible to restore full range by one manipulation, the limb is placed for a short period in the corrected position, which corresponds in most cases to the "position of election." For instance, the hip and shoulder are abducted and the wrist extended The joints are retained thus by appropriate splintage for a short time, which should rarely exceed twenty-four hours, in order to allow reaction to subside, heat and massage being given from the first. At the end of this period, movements are begun, active being more valuable than passive. It may, however, be advisable to refix the limb in the corrected position at the end of each period of movement for a variable period, which, however, should rarely exceed seven days.

In cases where the adhesions are more marked and in which a series of manipulations is necessary, active movements through the increased range are carried out after each manipulation, and temporary retention by splintage in the improved position is often desirable in the intervals of re-education.

In most cases, and in all in which adhesions are marked or have existed for a long period, a certain amount of muscular wasting exists, which may be general or affect some particular group. It may be due to disuse, or may be reflex in origin, and not infrequently both causes are present in combination. To preserve the full range

and relaxing muscular spasm, and in improving the circulation of the joint. After a simple manipulation, the patient is advised to exercise the limb under hot water, in addition to any special physical treatment prescribed. After manipulation of the spine a daily hot bath is prescribed as a preliminary to the essential spinal exercises.

The value of massage in the after-treatment of disabilities of the joints and spine has perhaps been overstressed in the past. Superficial stroking massage (effleurage) under the radiant heat or infra-red lamp lessens muscular spasm by a reflex effect, eases pain, and is a useful preliminary to re-educational exercises. Deep massage must be used with great care and discrimination. The deeply rooted custom of attempting to "break down" acutely tender fibrositic areas in this way subjects the patient to unnecessary pain and often to an indefinite prolongation of disability.

If massage is prescribed it is necessary to issue clear instructions to the physiotherapist concerning its relative importance in any scheme of treatment. In the after-treatment of stiffened joints its therapeutic value is negligible compared with the great importance of special re-educational exercises. If massage is not considered necessary, this must be clearly indicated, and unless the instructions are specific it will often be found that physiotherapists trained in former days (when massage received great emphasis) will devote nearly the whole session to massage and a mere five minutes to the vitally important re-educational exercises.

Finally, it must be emphasised that, whenever possible, the medical man who performs the manipulation should supervise the after-treatment; it is desirable, therefore, that he should have some knowledge of physical treatment, and particularly of methods of muscular re-education and of general rehabilitation.

apparatus. Another principle to be followed in re-education of muscles is that over-exertion is to be carefully avoided, particularly at first, and that the exercises must be increased daily by gradual stages At first the movements must be assisted, and later the movements are to be carried out against a gradually increasing resistance.

In this connection, exercises in the Guthrie-Smith Suspension Apparatus (Fig 126) are of considerable benefit *

Special occupational therapy is of the greatest value, as has been amply proved in the case of war pensioners with disabilities of the limbs and in the case of sufferers from the stiffened joints of chronic rheumatism. The psychological benefit of such therapy can scarcely be overestimated

Electrical stimulation of the affected muscles, particularly by surging faradism, is valuable in obstinate cases

Perhaps of even greater value in rehabilitation are exercises such as rowing, swimming or cycling, or the healthy rivalry of tennis or football Such exercises and games carried out in country surroundings, far from the atmosphere of hospital or nursing home, have an excellent effect upon morale, and their value in hastening recovery is very great, provided expert supervision is provided.

In the lower extremity, ambulatory exercises are greatly facilitated if they are performed in a deep pool bath, if available At certain spas, "under-water manipulation" is practised in slight degrees of joint or muscle stiffness with considerable benefit

Heat and Massage.—These are valuable preliminaries to the above-mentioned measures in nearly all cases. Their soothing effect tends to abolish muscular spasm, improved nutrition results from the increased vascularity produced, and it is probable that they have a softening effect on scar-tissue. They are particularly valuable in the more marked cases of adhesions, especially those associated with chronic arthritis

The forms of heat employed are innumerable, and vary from the homely hot-water bottle, poultice, or fomentation to such more complex methods as diathermy. A portable radiant heat or infra-red lamp should be in the armamentarium of every physiotherapist, and these forms of heat are the most generally useful after manipulation as a preliminary to movement. For a description of the various forms of heat and their application a textbook on physical medicine should be consulted.

Various other forms of heat may be of great value in soothing pain

* See "Rehabilitation, Re-educatior
Guthrie-Smith (Baillière, Tindall and Cc

disease process elsewhere, possibly shingles or housemaid's knee. The orthopædic or manipulative surgeon adopts the rational procedure of setting out to improve or cure the condition of the hip-joint itself by suitable manipulation. There is little evidence that the founder of osteopathy was ever concerned with the stiff or deranged joint *per se*, and the rational treatment of such by manipulation was well established long before Still raised the banner of osteopathy.

In the Bill for the Registration and Regulation of Osteopaths which was considered by a Select Committee of the House of Lords in 1935, osteopathy was defined as "that system of the healing art which places the chief emphasis on the structural integrity of the body mechanism as being the most important single factor to maintain the well-being of the organism in health and disease."

Ray G. Hulbert gives the following definition in the latest edition of the "Encyclopædia Britannica": "Osteopathy is a system of health and healing founded on the theory that the living body is a vital machine which will make the remedies necessary to protect itself against disease so long as it is in correct mechanical adjustment. . . . Structural derangement is considered as the most important underlying disease cause."

Dr. W. Kelman Macdonald gives the following definition in his book, "The Scientific Basis of Osteopathy": "Osteopathy is a manual method of healing. It is based on the fact that abnormalities in the human framework ultimately cause disease by interfering with the blood and nerve supply to the various tissues and organs of the body. Further, by obstructing the vessels which carry away waste products, these abnormalities allow other factors in ill-health to exert their influence unduly."

The Founder of Osteopathy.

This cult or system of "healing" was introduced by Andrew Taylor Still (1828-1917), of the United States of America, in the year 1874. A shrewd business instinct, allied to mystical fervour, led him to propound his views concerning the nature of disease and its treatment in pseudo-scientific language which was often fantastic, and occasionally lapsed into frank commercialism.

Still was by no means the first founder of a system of "healing" or of a new religion to realise that this combination of business acumen with a claim to divine inspiration never fails to make an irresistible appeal to the ignorant and foolish As an example of Still's literary style, the following extract from his autobiography

CHAPTER XII

THE CULT OF OSTEOPATHY*

Definition.

It is a common error to confuse Osteopathy with Manipulative Surgery.

There is, however, a great difference between the theories and practice of osteopathy as enunciated by Still and those of manipulative surgery as practised by the orthopædic specialist. Dr. W. Kelman Macdonald, in the foreword to "The Scientific Basis of Osteopathy," points out emphatically that manipulative surgery is not osteopathy.

Moreover, the Select Committee of the House of Lords stated in their Report in 1935. "In view of the fact that the establishment of a statutory register would give something in the nature of a 'hall-mark' to osteopathy, the Committee felt it their duty to inquire at some length into the nature and value of osteopathic treatment. It emerged clearly that osteopathy is not—as is popularly supposed—a craft or art limited to the treatment of maladies of the bones, joints, muscles, ligaments, etc, by manipulation . . . Osteopathy, however, claims to be a method of healing which is suitable for the treatment of *all diseases of any description.*"

Many orthopædic surgeons practise manipulative surgery, but are not osteopaths Let us give a few simple examples of the essential differences between these subjects

The osteopath, if a true disciple of Still, manipulates the spine, not primarily because it is itself the seat of symptoms, but in the misguided attempt to cure some disease—for example, epilepsy, diabetes, or even cancer.

The orthopædic surgeon, on the other hand, if consulted by a patient complaining of pain and stiffness of the spine due to adhesions, manipulates the spine, breaks down the adhesions, and often cures the patient If the osteopath manipulates the spine for similar conditions, he encroaches upon the domain of manipulative surgery.

Let us take another example. The true disciple of Still manipulates the hip-joint, not for the rational reason that it is stiff and painful and crippled by adhesions, but because he hopes to cure some

* In the preparation of the historical portion of this chapter the author acknowledges his indebtedness to a valuable publication entitled "What is Osteopathy?" by Drs Charles Hill and H A Clegg (J M Dent and Sons, Ltd)

given before the Select Committee of the House of Lords, and Yale Castlio, a leading osteopath, states in his "Principles of Osteopathy": "Among the classes of chemical agents that the osteopathic physician will find useful or indispensable are the antiseptics, anæsthetics, stimulants, sedatives, anodynes, cathartics and narcotics. In addition, he should be familiar with those drugs which have curative value in such conditions as syphilis, malaria, and certain parasitic diseases of the gastro-intestinal tract; with those that have preventive value, such as iodine in endemic goitre regions, and with those that are of value for purposes of diagnosis, such as atropin during Roentgen examination of the gastro-intestinal tract, ephedrine in nasal examinations, and the dyes employed to visualise the gall-bladder and renal pelvis."

Such heresy must surely make the founder of osteopathy turn in his grave, for Still wrote. "He who so far forgets God's teaching as to use drugs forfeits the respect of this school and its teaching." Although osteopaths frequently refer to orthodox practitioners as "drug doctors," no accusation could be further from the truth. One has only to observe the enormous strides made by physical medicine and the stress now laid upon preventive medicine, physical training, diet, and exercise to realise this.

Still argued that disease is due to misplacements or maladjustments, which cause obstruction to bloodvessels and nerves followed by "physiological discord," and that this "discord" could be removed by "adjustments" or manipulations. These "misplacements" were of the nature of dislocated ribs, hips, or spinal joints.

The discovery of the X-rays by Roentgen made the dislocation theory untenable, and the modern osteopath finds it convenient in many cases to overlook the great stress that Still laid upon dislocations as a cause of disease. In the case of the spine, Still attached particular importance to dislocations in the cervical region. He states· "I could twist a man one way and cure flux, fever, colds and the diseases of the climate; shake a child and stop scarlet fever, croup, diphtheria; and cure whooping-cough in three days by a wring of the child's neck."

The Teaching of the Modern Osteopath.

In considering this important subject, we are faced at the outset with the extraordinary diversity of views which have been expressed, from time to time, by various exponents of osteopathy as to the actual nature of the osteopathic "lesion." It has been well said that "the osteopathic lesion is as elusive as the philosopher's stone.

may be quoted "Twenty-four years ago, the 22nd day of next June, at 10 o'clock, I saw a small light in the horizon of truth It was put into my hand, as I understand, by the God of Nature. That light bore on its face the inscription 'This is My medical library, My surgery and My obstetrics. This is My book with all the directions, instructions, doses, sizes, and quantities to be used in every case of sickness, and birth, the beginning of man, in childhood, youth and declining days.' "*

The commercial side is well shown by the following quotation "My successes have produced on me the feeling that I am a great financier and a great business man I can put my hand on much more money which is my own than I have ever hoped to be able to do . . . I feel that the unfortunate ought to ask my advice first of all men, because I am successful" His brother Jim was at first sceptical, but later became converted to the financial opportunities of osteopathy, and wrote "Hallelujah, Drew, you are right, there is money in it, and I want to study osteopathy"

The Theories of A. T. Still.

Still's attitude towards orthodox medicine can be traced to a domestic tragedy. During an epidemic of cerebro-spinal meningitis, he had the misfortune to lose two of his sons, although the best medical advice was available. There can be little doubt that this event brought about his uncompromising hostility to orthodox medicine. Henceforth, the argument was that since drugs failed to save the lives of his sons, drug therapy was useless

"Not until I had been tried by fire," he writes, "did I cut loose from the stupidities of drugs Not until my heart had been torn and lacerated with grief and affliction could I fully realise the inefficacy of drugs"

In another place, he maintains the theory that the body itself is self-sufficient and contains all the remedies necessary to health These remedies "can be administered by adjusting the body in such a manner that the remedies may naturally associate themselves together, hear the cries and alleviate the afflicted"

The modern osteopath, although paying lip service to the original theories of the master, has been compelled to abandon this extreme point of view. This fact was clearly demonstrated by evidence

* Mrs Eddy, the founder of Christian Science, who amassed a large fortune, affected in her writings a somewhat similar and equally grotesque travesty of the Apocalyptic manner of writing (See "Our New Religion," by the Rt. Hon H A. L Fisher, Thinker's Library, Watts and Co)

evidence to support this theory concerning the nature of the osteopathic lesion. Why, moreover, should a lesion in the form of strain or sprain of any joint be labelled "osteopathic"? Why not "orthopædic lesion"? Have not strains of various joints been within the legitimate province of orthodox practitioners of medicine for centuries?

The modern osteopath asserts that "lesions" may be primary or secondary. Primary lesions in the spine may be due to trauma or chill, and secondary lesions are brought about by inefficient functioning of the sympathetic system which has caused derangement of some organ or viscus, which in its turn produces a spinal lesion. This secondary spinal lesion may affect other regions of the body by reflex action. It is alleged that the bones are not actually displaced, but are fixed in some position within the normal range of movement, and the osteopath claims to break a vicious circle by performing spinal manipulation.

When enquiry is made concerning the scientific evidence upon which the osteopath bases his theories, reference is made principally to the *Bulletins* of the A T. Still Research Institute.

Space will not permit a detailed criticism of this "research." The ignorance of elementary physiology and pathology displayed in these *Bulletins* is profound, and is only equalled by the complete absence of recognition of the nature of scientific evidence.

There are many who, after a perusal of the *Bulletins*, will agree with Blundell Bankart when he states. "These pamphlets are a revelation of the way in which a subject can be 'written up' in pseudo-scientific language for propaganda purposes."

Those who require further evidence concerning the osteopathic theories should consult the Report of the Proceedings before a Select Committee of the House of Lords on the Registration and Regulation of Osteopaths Bill, 1935, published by the British Medical Association.

As an example of the evidence given by the osteopaths before this Committee, the following quotation from the evidence of Dr. Kelman Macdonald concerning the osteopathic theory of infectious diseases may be given.

Sir William Jowitt "There is no evidence, is there, to suggest that the persons who escape the ravages of the typhoid bacillus are people who are osteopathically sound, and that those who fall victims are osteopathically unsound? Have you any evidence of it?"

Dr Macdonald: "No evidence; it is merely our idea."

Later, in discussing the osteopathic theory in connection with pneumonia, Sir William Jowitt elicited from Dr. Macdonald the

Like man, it has in its time played many parts a dislocated hip, a twisted rib, a dislocated spine, a contracted muscle, an acid muscle, a fixed joint, a strained joint. It presses and it does not press. It is swollen and it is contracted. It can be demonstrated by X-rays and it cannot be so demonstrated. It has been seen post-mortem and it has not been seen post-mortem. . . . It is the perfect alibi."*

It is sometimes asserted that the medical profession is opposed to osteopathy from jealous and selfish motives. This is untrue. Medical men are willing and even eager to accept any method of treatment, whatever its origin, which contains possibilities of alleviating human suffering It should never be forgotten, however, that it is the duty of the profession to safeguard the public against any method of treatment which is potentially dangerous. Secondly, if any cult or method of treatment boldly asserts that orthodox medicine is based upon false pathological principles, and that all the great pioneers of medicine were in error, such a cult must be prepared to substantiate its revolutionary claims by evidence that will stand careful and impartial scientific investigation Can any educated member of the public, or even an osteopath, logically object to such conditions ?

Reference has already been made to the difficulty in deciding what an osteopath means when he refers to the " lesion." Some osteopaths adhere firmly to the original doctrines of Still concerning maladjustment of the bones and particularly of the vertebræ, while others have " fallen from grace." Amongst the latter is Dr Kelman Macdonald, who describes the master's teaching as " a delightfully simple but utterly erroneous hypothesis " !

Castlio, after stating in his textbook that 90 per cent. of the diseases encountered in general practice are due to osteopathic lesions, goes on to define the lesion as a " roughly spherical area of diseased and disordered tissues, having as its approximate centre a disturbed spinal articulation, and including within its diameter one or more segments of the spinal cord and one or more pairs of sympathetic ganglia "

Dr George Macdonald and Mr. Hargrave-Wilson give the following definition in their book, " The Osteopathic Lesion," published in 1935 for medical readers: " The nature of the lesion is an acute or chronic joint strain," and they further state that " the moment definite pathology, other than that of acute or chronic strain, develops, the lesion is no longer essentially osteopathic "

Unfortunately, the authors do not bring forward any scientific

* " What is Osteopathy ?" by Drs Charles Hill and H. A Clegg

pointed out that as there was no proper definition of osteopathy the new Board would be given unlimited power to define " treatment commonly given " by osteopaths, and that in consequence every medical practitioner would be prohibited from practising within the undefined field of " osteopathy." To carry this to its logical conclusion, any orthopædic surgeon could be fined for manipulating the spine, or any medical practitioner could be precluded on a strict interpretation of the Bill from practising medicine !

Clause 6 would grant a wide monopoly to multitudes of inferior practitioners who may (or may not) have had some medical training; which training, however, would have been biased throughout, incomplete, and satisfying lesser and different requirements to those required by the General Medical Council.

The legalisation of the clause permitting osteopaths to sign birth and death certificates and to administer anæsthetics would expose the public to dangers and abuses beyond computation.

Findings of the Select Committee of the House of Lords appointed to Consider the Bill for the Registration and Regulation of Osteopaths.

The Committee of seven members, three of whom had previously been warm supporters of osteopathy, decided unanimously that the Bill " be not further proceeded with." The Committee found that the claim that osteopathy is a method of healing suitable for the treatment of all diseases " has not been established, and that it would not be safe or proper for Parliament to recognise osteopathic practitioners as qualified, on a similar footing to that of registered medical practitioners, to diagnose and treat all human complaints."

Another important finding was that " the only existing establishment in this country for the education and examination of osteopaths was exposed as being of negligible importance, inefficient for its purpose, and, above all, in thoroughly dishonest hands "

This indictment was not unexpected by those who had watched the proceedings and the pitiless exposure of the osteopathic claims to the light of reason Indeed, before the evidence of those opposing the Bill had been concluded, it was precipitately abandoned by its promoters.

Explanation of Apparent Cures by Osteopaths.

If the osteopathic theories were harmless, the cult might be safely ignored and allowed to die a natural death, but they are in many cases extremely dangerous. Osteopaths pay little or no attention

following statement. "We contend, and contentions are not proof, that if a person is osteopathically sound, that organism will not get a chance to start. It is the few hours that count. I could go over all the persons in the room, and I think I would be able to tell you which would stand a good chance of getting pneumonia and which would not, we have evolved our art to that high degree"

The Bill for the Registration and Regulation of Osteopaths.

In 1931 the British Osteopathic Association applied for a Royal Charter, and, on four occasions, parliamentary Bills have been introduced in order to confer upon osteopathic practitioners the same legal status as that conferred upon registered practitioners

The last Bill was introduced in 1935 and referred to a Select Committee of the House of Lords. The object of the Bill was to "place the practice of osteopathy, as a developing system of treatment of disease by manipulative methods, under the control of a Statutory Board with power to enforce a prescribed standard of education and professional competence upon all osteopathic practitioners." A few of the principal clauses may be mentioned.

Clause 2 gave a definition of osteopathy that was extraordinarily vague "The practice of osteopathy shall be deemed to include the performance of any such operation and the giving of any such treatment, advice, or attendance as is commonly given by osteopaths, and any other necessary measures required for the efficient performance of osteopathy."

As every osteopath appears to have a different idea of what is meant by osteopathy, it was perhaps wise that no concise and straightforward definition was even attempted

Clause 6 stated that during the first twelve months three classes of persons should be registered

(*a*) Graduates of approved British schools of osteopathy.

(*b*) The holders of certificates of approved Dominion and foreign diplomas.

(*c*) Persons who had been engaged in the practice of osteopathy for three years

Clause 7 (2) proposed that osteopaths should have the right to sign certificates of birth and death, and to administer anæsthetics and perform minor operations.

Clause 8 (1) —No person shall, unless he is registered under this Act, practise osteopathy.

The British Medical Association, in commenting upon the Bill,

striking success although his own explanation of its occurrence is erroneous.

3. In the third category, are the patients suffering from pains, often of a neuralgic nature, in various areas of the trunk or limbs. These are referred along the distribution of the spinal nerves owing to some pressure at their vertebral exits, often due to rheumatism or to the after-effects of injury. Familiar examples include many cases of occipital neuralgia due to pressure upon the upper cervical nerve roots, or of brachial or intercostal neuritis causing pain in the upper extremity or chest, certain cases of obscure abdominal pain, often wrongly diagnosed as due to some intra-abdominal lesion, and many cases of sciatica due to pressure at the vertebral exits of the spinal nerve roots. Very many cases of such sciatic pain are caused by compression of the sciatic nerve roots by scar-tissue due to early vertebral arthritis in the lumbar or lumbo-sacral regions. For many years the author has practised manipulation of the lumbar spine in this type of case, and, in his experience, the results are usually better than the orthodox immobilisation, although admittedly the latter may be sometimes necessary. Dr. C. W. Buckley has ably reviewed the problem of referred pain in spinal arthritis ("Nervous Manifestations in Vertebral Rheumatism: Reports on Chronic Rheumatic Diseases," vol. 1).

When the osteopath manipulates the spine for any of the above conditions, he may relieve or cure the patient. Without an exhaustive examination, however, the risks of spinal manipulation are great, and for this reason such manipulations should only be performed by an experienced surgeon The osteopaths have also evolved a technique of manipulating the spine and of producing the maximum degree of movement between individual vertebræ which is worthy of study. As we have already seen, the treatment of these conditions really belongs to the realm of manipulative treatment proper, and the danger of building up a revolutionary system of medicine upon such a slender hypothesis, unsupported by scientific evidence, is so incalculable that it is our duty as guardians of the public health to fight against this menace.

In conclusion, what should be our attitude as a profession if, as is possible, another attempt be launched by the osteopaths for State registration and recognition in this country? It is clearly our duty to the public to oppose strongly any such official recognition. Even a limited form of State recognition would be interpreted as a licence to diagnose and treat all forms of injury and disease, with disastrous results to the standard of public health in this country.

to scientific methods of diagnosis. Consequently, patients with malignant disease or other serious conditions often waste precious time and, incidentally, much money in this futile treatment, while the conditions from which they are suffering are steadily deteriorating and cancer cases may thus become inoperable. Many of us see almost daily in our practices the futility and danger of osteopathic treatment. As an example of its futility, many patients have received long courses of manipulative treatment to a normal spine, while some joint stiffened by adhesions has been completely overlooked.

Space will not permit the dismal recital of some of the tragedies resulting from this method of treatment that have been observed. Yet it must be admitted that osteopaths sometimes effect cures in patients whose conditions have defied more traditional methods, and it is of the utmost importance that we should face this fact squarely and endeavour to ascertain how these cures are brought about. These cases can be classified into three main categories, *all of which in reality belong to the domain of manipulative treatment proper.*

1. In the first category are the patients whose symptoms are actually situated in the spinal column or back, and in which the alleviation or cure is due to the breaking down of adhesions in ligament, muscle, or aponeurosis.

2. In the second category are the patients whose symptoms are not actually in the spine but elsewhere, these symptoms being principally of the nature of a neurosis These persons have often been under the care of many doctors, and the true nature of the symptoms having possibly been unrecognised, faith has been lost in orthodox practitioners. We are only beginning to realise the vast importance of the psychological factor in medicine and the part played by suggestion in treatment The factor of suggestion may often be applied in curious but very effective ways Some years ago, an irregular practitioner toured the music-halls and brought about astonishing "cures" by stroking patients with a gigantic magnet. Many of the successes of Christian Science and some of the miracles at Lourdes may be explained in this manner. The dramatic treatment of the osteopathic "lesion" is one of the cleverest and most effective forms of suggestion that has ever been devised. The diagnosis of the osteopath, after the period of doubt and disappointment, impresses the patient by its directness and apparent simplicity—"a bone is out of place and is interfering with the blood supply." The simplicity of the theory, the conviction with which it is uttered, and the actual treatment by spinal manipulation, all act by powerful suggestion. Thus the osteopath may bring about a

INDEX

We shall not adopt this attitude from jealousy or prejudice, but because it is our duty as a profession to safeguard the health of the nation.

Δεῖ γε μὴν ταῦτα εἴδοτα μὴ λογισμῷ πρότερον πιθανῷ προσέχοντα ἰατρεύειν ἀλλὰ τριβῇ μετὰ λόγου.

[He who knows will endeavour to cure not on the basis of probabilities but remembering that medicine is practice with reason —*Hippocrates*]

B

C

D

E

L

M

N

O

P

Printed in Great Britain by
Billing and Sons Ltd., Guildford and Esher
F6847

T